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## COAL CONSUMPTION IN CENTRAL STATIONS.

THE Committee on Data of the National Electric Light Association are doing good service in their investigation into the costs of running electric light stations. The *Electrical World*, which publishes the table issued by the committee, describes the coal consumption of some stations as appalling, instancing a station not 50 miles from New York, where thorough data are recorded, and the coal consumed per kilowatt hour is 23·9 pounds in summer and 13 pounds in winter, the load factor being 25 and 55 per cent. respectively. The table shows what may be usually expected from various conditions, and is thus useful as a guide in designing a station in respect of size of units, &c. Thus, small units lose efficiency very rapidly with light loads, while large engines will run with fair economy between quite wide limits, a large compound condensing engine, for example, only varying its water consumption by half a pound between 750 and 2,200 horse-power, and a 500 H.P. engine varying but one pound between 200 and 500 H.P., while with such efficient types of engine the ratio between the water consumption of the smaller and larger sizes is smaller than with less efficient types. The largest output per pound of coal was 262 watts, the coal being half soft coal and half hard screenings. In this case the water consumption was 17 pounds and the fuel duty 9·37 pounds evaporated. An evaporation of 11·3 pounds is recorded, but is nullified by a water consumption of 32·7, the boilers being horizontal tubular, and the engines non-condensing belted compound Corliss, and high speed simple belted non-condensing. In the case where 262 watts per pound of coal were yielded, the engines were triple compound direct connected with water-tube boilers and feed heaters, and hand fired. The highest evaporative duty was with a vertical water-tube boiler with economiser, and using washed Illinois pea coal, but there is not sufficient information to enable any general argument to be made as to any specially superior boiler plant. We cannot tell, for example, how much of the 11·34 pounds evaporative efficiency is due to the economiser, and how much is due to the priming of a vertical class of boiler—a fault apt to attend vertical boilers, especially as we find 23·6 pounds of water per horse-power with compound condensing engines. It is a pity that so much difficulty is found by the committee in obtaining the desired data, for if the records could be made fuller, a general average from particular types and arrangements could possibly be made out from the data and such types avoided as showed average poor results. A given type of boiler with a certain rare stamp of man may show abnormally good results, yet it would be unwise to choose such a boiler to be used by the general average of men. In no case in the table given do we find any mention of super-heating or

jacketing, though we can scarcely think both these adjuncts to economy are absent in every case from the engines of which data are given, while in two cases only is there an "economiser" feed heater. The usual type of boiler appears to be of the horizontal tubular variety—a cheap easily made boiler, under-fired and very much used in America, and fairly safe if fed with good and hot water, though we should be very sorry to stand by too many of them with usual American pressure allowances.

That an engine when underloaded becomes wasteful is everywhere recognised. With steam carried the full length of the stroke every engine is of course wasteful. As a degree of expansion is allowed there is a very great relative economy, and this economy may be still further increased by further expansion, but only to a certain limit, and this limit is reached within a surprisingly short limit, so that in a simple engine an expansion of three to six-fold is all that ordinary practice will warrant. The main reason why expansion failed to give results at all conformable with theory was simply that the bulk of steam used bore a small ratio to the weight, or should we say area of the cylinder metal to which it was exposed, and the amount of initial steam thus lost became very great until at a cut off of, say, 1 per cent., the steam consumption is practically equal to that at a 2 per cent. cut off, and it is obvious that in this extreme case the one cut off would show an efficiency double that of the other. The question of internal engine friction must also have its effect so far that the terminal pressure of expansion can never, for best mechanical efficiency, be less than what will give a forward pressure sufficient to run the engine at normal speed, and, in this way, a limit is placed to the ratio of engine size, and duty. Neglecting this for the moment, it is obvious that there is no other reason for limiting the ratio of expansion in a cylinder than the thermal reason, and that could the cylinder be maintained as hot as the boiler the mechanical reason would be the only one for limiting the expansion. The gas engine has been a great teacher; it has taught us that a cylinder can be lubricated, even if much hotter than a steam engine cylinder, and it ought to encourage the use of hotter and drier steam than has yet been attempted, especially as it is likely that no superheat that has so far been tried has abolished cylinder condensation—merely reduced it. The American records, to which we have alluded above, are powerful arguments in favour of more attention being given to the thermal side of steam working; not simply the question of heating the steam and of steam jackets, but also of that important item the extent of the internal surfaces, which are almost always far in excess of what they need be, as well as infinitely inferior in quality to what they should easily be made.

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Experiments with Bare Telephone Wires Laid on the Ground.

The German Post and Telegraph authorities have been making some interesting experiments to test the value of different kinds of telephone line wires when laid without insulation upon the ground. The chief end in view was to ascertain whether there was any advantage in using the recently introduced compound wires having a core of steel and an outer coating of copper, bronze, or other highly conducting metal. The experiments showed that these wires had no advantages over pure copper wires. Incidentally, also, the experiments showed the distances to which speech might be transmitted by bare telephone wires resting on the ground without insulation. The wires were laid in a zig-zag course on a wet clay soil in a field near the Rhine. The total length of the wire experimented with was about 2½ kilometres. A telephone was connected up at each end of the wire, the other terminal of each telephone being put to earth by connecting it in one case to a system of water pipes, and in the other to a metal plate immersed in a brook. In the first experiments the wire was fastened to the ground, at intervals, by wire staples. It was found that speech could not be heard till these staples were removed. When they were removed, however, the speech could be distinctly heard. A compound metal wire of 0·6 mm. diameter, and a pure copper wire of 0·45 mm. were tried, but no difference could be detected between the two. When a part of the wires was immersed in the water of the brook, it was found that speech transmission was extinguished by the immersion of 28 m. of the compound wire, and 50 m. of the copper wire. Here, therefore, the copper wire showed a distinct advantage over the compound wire. Wires of larger diameter (4 mm. copper, and 3 mm. galvanised iron wire) were laid in the field, but the results were found to be distinctly inferior to those given by the thinner wires. It appeared that the greater weight of the thicker wire produced a better contact with the ground, and that this more than counterbalanced the advantage derived from the reduced resistance. An experiment with a 0·2 mm. wire (thinner than the first wire) confirmed this view. Though the resistance of this wire was about forty-four times that of the first wire tested the transmission of speech was found to be quite as good, owing to the greatly reduced weight and surface in contact with the ground.

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Electricity in Textile Manufacturing.

In no branch of modern industry is closer attention paid to economy and to every mechanical detail which goes to make up the commercial success of a manufacturing plant, than in mill work as practised to-day by the leading cotton and woollen firms. Driven by the high cost of labour to seek every mechanical advantage that human ingenuity can suggest, mill engineers are at once the most conservative and the most keen-sighted for improvements of any set of technical workers to be found. They are slow to act when new ideas are broached, but having once made up their minds they carry out the work with the greatest sagacity and skill. It has thus happened that the electric motor has found its way into almost every kind of manufacturing establishment, except those connected with the textile industries. The first cotton mill to be fitted with electric motors for the complete distribution of power throughout the plant, is probably that of the Columbia Cotton Company at Columbia, South Carolina, U.S.A., and it must be admitted that the plunge—for it was a hazardous undertaking—has been crowned with complete success. In a recent issue of *Cassier's Magazine* Dr. Louis Bell describes the whole installation, with copious illustrations; and it is clear from his description that the results of this bold undertaking will not be regretted by the shareholders of the company. Space will not, to use a hackneyed expression, permit of our dwelling upon the details of the plant installed. It is sufficient for us to enjoy the gratification of recording the results, which are eminently satisfactory in every respect. True, the Columbia Cotton Company possesses the advantage of a good situation and ample water-power; but that only emphasises our old contention, that when new works are established they should be established in the most advantageous positions. We shall expect to see many other mills engaged in the textile industries following this American "lead."

## WAVES AND VIBRATIONS.

### V.

In considering ordinary aerial waves it is necessary to make an appeal to the imagination. To show the character of the motion producing them it is usual to adopt some method of intermittent illumination, or, as it is commonly termed, a stroboscopic method. Tuning forks are often used as sources of pure sound and as standards of pitch, there is a slight change in their frequency with changes of temperature, but they are convenient and accurate. To show the production of "beats" Lord Rayleigh used a fork of 256 periods per second, another and similar fork was loaded and both were caused to speak together. They then co-operated, and at intervals, when one was producing a condensation, the other would give rise to an equal degree of rarefaction and a "beat" would be heard. In the experiment actually performed sixteen beats were counted in a quarter of a minute. To prove which had the highest frequency, the loading was altered on the second fork so as to raise its pitch, the alteration in the number of "beats" then indicated the relative pitch of the two.* Four beats per second, or more even, can be counted by musicians in whom the faculty for counting is more developed than as a rule is the faculty for pitch discernment. It is possible to count even ten per second, but very much slower beats are more favourable for absolute accuracy. The limit is found by the number of beats which can be obtained. If the sounds are dying away the fall in the sound may be confused with the beat, but in the case of sustained vibrations this source of confusion no longer exists.

The revival of sound which occurs after a period of silence due to the beat is not in the same phase as would be the case had the sound merely been shut off, say, by a valve or stop-cock. Lord Rayleigh advised those who were anxious to learn something about this subject to take up "Tyndall's Lectures," or if they were studiously inclined they might proceed to more exhaustive treatises, such as his own. The relative phases of waves dying down at a beat and those merely shut off and thrown on again are indicated in fig. 11.

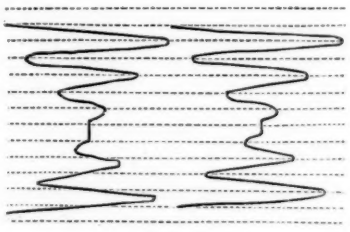


Fig. 11.

Sound travels through air at a pretty high speed, some 1,100 feet per second. High and low notes travel at about the same rate, as must be the case if we consider that the music of a band, say, half-a-mile off can be heard. Newton treated air as an elastic fluid, and was the first to measure the velocity of sound on mechanical principles.† Laplace accounted for a discrepancy of one-sixth by allowing for the heat developed in air when it is compressed. Lord Rayleigh showed how a resonating tube could be used to make the determination of wave length and therefore the velocity as the frequency was known; water was poured in until the tube acted as a powerful resonator when the fork previously used was held over it, the length was found to be $11\frac{1}{2}$ inches. Then $\frac{11{\cdot}5 \times 4 \times 256}{12} = 978$ feet per second. Attention was drawn to the fact that the length of the tube was only one quarter the wave length, and that the measurement of length should be corrected by a factor for the open end. The subject of resonators was introduced by recounting the curious behaviour of a magnetometer at one time used by the lecturer. When it was shaken remarkable disturbances occurred, the mirror tended to turn round its delicate silk support so as to obstruct the orifice in which it hung. The experiment was repeated with a resonator in whose throat a small paper circle was suspended. When the note to which the resonator was sensitive was sounded, the disc set itself so as to cause maximum obstruction of the air stream, in other words, across the mouth of the resonator, and it executed oscillations about its equilibrium position. The frequency to which a resonator responds is halved if the dimensions be magnified double. In dealing with resonator experiments it is a little difficult to follow what happens, air being invisible and the motion is periodic at a rate too quick to be followed by the eye. This can hardly be overcome when the vibrations are very small. Prof. Boys has adapted his fibres of quartz to an instrument which is based upon the foregoing suggestion of Lord Rayleigh; it practically consists of a resonator, in the mouth of which a disc is hung. Attached to the disc is a prism, used to totally reflect a beam of light thrown upon it and sent out on to a scale. This mirror resonator is in acoustics what the mirror galvanometer is in the study of electricity. At the right pitch it responds vigorously, as was shown by an organ pipe, and the selection of pitch is considerable. The instrument actually on the table responded best to E and E flat on the harmonium.

Another method of experiment was to make use of Kundt's phenomenon. At nodes where the pressure varies most no motion is perceived if cork filings or light dust be present as an indicator. The loops, striations, and leaves or blades were shown when a tube was closed at one end and a rod was laid horizontally and fixed in the middle with one end inserted into the tube. On rubbing the rod the impulses of the free end produced stationary air waves in the glass tube, by which the cork filings became arranged in regular figures. Koenig's explanation of the striations and leaves or blades is indicated by fig. 12. Where the velocity is greatest the pressure is least. There is less motion in the interior, and the particles of cork appear to repel one another; at *b* there is more motion in the neck, and the two spheres appear to attract one another. This explanation is just the reverse of that given for the disposition of iron filings to arrange themselves in a magnetic field. The two arrangements which can be adopted by the cork filings are the filamentary or the laminar. This experiment has been used to determine the velocity of sound in argon, which gives results similar to mercury vapour. The question of specific heats can be settled if the velocity of sound in and the density of the gas be known.

Fig. 12.

The acoustical section of the fourth lecture was commenced by Lord Rayleigh giving some particulars of tuning forks—so much used in acoustical work. Two masses as equal and equally arranged as possible should move in and out along a straight line. This is the theory of the fork, and according to it the centre of gravity undergoes no motion or, at least, there should be no tendency to set the centre of gravity into motion. As a rule, however, some motion is transmitted down the stalk, the tuning fork of practice is not the tuning fork of theory. This question has never been discussed. The balance is not complete and Lord Rayleigh believes it ought not to be complete. If the prongs be bent in or out there must be a position at which no motion would be propagated down, but a complete symmetry must be maintained between the two arms, and herein lies the difficulty. A fork was shown on whose prongs brass balance pieces had been fitted, the adjustment was so close that placing its stalk on a sounding board had little effect, but its efficiency had been diminished, and Lord Rayleigh stated he could hear something like an octave difference between the fork on and off the sounding board. If the balance had been complete nothing would have gone down the stalk. Due to what might be called centrifugal force, however, a push would act down the stalk of twice the normal frequency. Rather absurd notions have found their way into print as to how the motion is conveyed down the stalk. One of the theories postulates

* We might refer to Kohlrausch's "Physical Measurements," third English edition, p. 141.

† *Principia*, Book 2, Section 8.

a difference in the motion conveyed by the central and outer fibres of the material of which the fork is made, but it is clear that the motion transmitted is due to the centrifugal force, as it may be called, or to want of symmetry between the prongs.

In the fork as ordinarily used the vibrations rapidly die out. To maintain vibrations it is necessary to replace the motion constantly being lost. The bow and fork give temporary sounds and so does the pianoforte, but examples of maintained sound are found in the organ or harmonium. One of the simplest sources of maintained sound is the electrically-driven tuning fork. The arrangement consists of a fork, attached to the lowest prong of which is a dipper making contact with the mercury in a cup placed below it. The circuit comprises the battery, contact, and an electromagnet lying between the prongs of the fork. The ordinary explanation of the action which takes place is entirely illusory, as it introduces forces of such a nature that they depend upon the position of the prongs. If this were true, as much harm would be done during one part of the movement as good was done during the other part. A complete explanation must take account of the way in which the prongs are moving through any position. The magnetic forces do not depend entirely upon the position of the fork as they lag behind the motion giving rise to them. Thus a better contact is made with the mercury when the dipper is coming out than when going in, as a certain amount of air has to be got rid of in the latter case. Self-induction also acts so that the current would not at the first moment reach its full value. It is therefore essential that the forces should not depend only on the position of the body.

## THE INCANDESCENCE LAMP.

By A. BAINVILLE.

(*Continued from page* 96.)

We will not here give a description of the Bunsen photometer, as it is well known; we will merely observe that the nature of the paper of which the screen is composed, and that of the grease spot, exercise a considerable influence on the accuracy of the measurements. A type of the Bunsen photometer, in pretty general use, is that in which the screen which normally receives the light from the two sources to be compared, is in the plane bisecting two mirrors, by means of which the grease spot can be seen on both sides of the screen at once. When two luminous sources of the same colouring are compared by this apparatus, the grease spot disappears at the same time in the two reflections of the screen given by the mirrors; however, these two reflections are at too great a distance from one another for them to be easily compared; the employment of a prism brings the two reflections together, and thus facilitates their comparison; these two modifications of the Bunsen photometer are due, the first to Rudorff, the second to M. von Hefner Alteneck.

We will briefly describe the mode of observation in the Bunsen photometer. The photometer and the two sources of light to be compared are placed on an optical bench; these two sources are so placed, that the straight line connecting them passes normally through the screen of the photometer. The position of the screen between the two sources is varied, until the grease spot on this screen disappears. This happens when the quantity of light received on the screen is the same on both sides; we take it for granted that the two faces of the screen are identical as to optical properties; by turning round the movable screen we, to a great extent, eliminate this source of error.

We have said that the methods employed at the works for the photometric measurement of lamps were not the same everywhere. But in no case is the mode advised above followed, for the photometric screen is never displaced on the bench.

Sometimes, while lamps of the same type are being measured, the two luminous sources and the screen are left fixed; the regulation is effected by varying, by means of a rheostat, the difference of potential at the terminals of the lamp to be tried, until it is made to give a certain number of candles; then by measuring this difference of potential and the intensity of the current passing through the lamp, its *régime* of working is known.

However, if the lamps are uniformly made, which is a result that every maker should endeavour to obtain, the above method might be modified in the following manner:—The brilliancy of the lamp is kept constant, and it is displaced with regard to the screen, which remains fixed, as well as the standard of comparison, until the grease spot disappears. The difference of potential at the terminals and the intensity are then measured as above.

The arrangement of a room to be used for the purpose of photometry is of great importance as regards the accuracy of the results to be obtained. It must be painted in dead black; but again it is essential that it should be properly ventilated when naked lights are used as standards. These lights only give a constant luminous intensity on condition that the air is uniform in its composition, that it is still, and lastly, that the temperature is to all intents constant. If these conditions are not observed, serious errors may occur.

Besides the optical bench, on which are placed the photometer and the two sources of light to be compared, the fitting up of the photometry room includes various other apparatus. In the first place, the bench must be provided with a divided rule, so that the respective distance of each source from the spot on the photometer can be measured, indices fixed on the three supports enabling these measurements to be easily read. By means of a regulating rheostat, the difference of potential at the terminals of the lamp that is being tried can be made to vary at will; lastly, measuring instruments, a voltmeter and an ampèremeter for rapid readings, which are frequently re-standardised, together with the standard of light, complete the fitting up of the room. A wattmeter may also be employed with advantage in determining the brilliancy of the lamps.

The question of luminous standards has given rise to a great deal of controversy, and we are still far from having arrived at a satisfactory decision, in practice, at any rate; so that to the inaccuracies of photometric measurements must be added uncertainty as to the value of the standards adopted. It is impossible to use in practice M. Violle's absolute standard, which was adopted and defined by the International Conference of 1884. The lamp maker must therefore have recourse to secondary standards. The decimal candle adopted as a practical unit by the International Congress of 1889 has not been realised practically; it is, certainly, to all intents equal to the tenth of the Carcel, but the employment of the latter requires such precautions in order to eliminate all sources of error, that it cannot be employed to any great extent in industry.

It is, therefore, greatly to be desired either that the relative value of the practical standards actually in use should be officially defined, or that a new one of a certain determined value, and that can easily be used should be created, or, lastly, that some other method should be sought for determining the luminous power of any source whatever.

The standards now in use in lamp factories are of two kinds—the primary standards and the derived standards. The primary standards are the luminous sources that have been, up to now, studied in the laboratories, but the values of which, as compared with the practical standard (the decimal candle), are only imperfectly determined. Such are—the Carcel lamp, the English candle, the German candle, the Vernon-Harcourt lamp, and the Hefner-Alteneck acetate of amyl lamp. These various standards require very delicate handling.

The Carcel lamp in particular does not preserve its uniformity long at a time, and its regulation is too tedious for it to be employed constantly throughout the day; but it can be used for the study of derived standards. The Vernon-Harcourt lamp and the acetate of amyl lamp require less attention to make them work regularly; the latter, especially, is so simple in its construction and manipulation, that it can be employed directly if certain precautions are observed.

The derived standards may be incandescence lamps or gas jets suitably regulated, which are standardised by means of one of the primary standards. We thus obtain luminous sources that can more easily be kept constant and that are more convenient for industrial purposes. If incandescence lamps are used as derived standards, we must have a series that can be

compared one with another every day, and from time to time, with the primary standard, for it is evident that their luminous power will vary after being in service for a longer or shorter period; if we use gas jets, they must be standardised before each series of measurements, and it is indispensable that the pressure and the nature of the gas should be constant throughout the measurements, and also the state of the atmosphere, an essential condition in the case of luminous sources obtained by combustion.

These practical standards may be carefully studied in a special laboratory with the help of the Carcel lamp, for instance; their value is then known fairly accurately. Nevertheless, when we consider that they are derived from a standard, the value of which as compared to the practical unit is only imperfectly known, and that the mode of comparative measurement adopted is not capable of very close approximation, we see that the derived standards currently employed in lamp factories have really a very uncertain value.

In order to eliminate the errors resulting from the comparison of lights of different colours, and so obtain greater accuracy in photometric measurements, M. Crova proposed at the International Congress of Electricians in 1889, who afterwards seconded his proposal, the employment of a well defined term of comparison. This method consists in effecting the measure of the luminous intensity in that part of the spectrum, the wave length of which is 582; experiment having shown that the whole of the luminous radiations bear the same relation to one another as those measured in this division. The tint of the light will then be defined by the ratio of the intensities of the two lights in the division approaching 657, when these two lights have been equalised for the radiation, 582. A vessel containing a mixture of perchloride of iron and chloride of nickel, which is interposed between the luminous source and the screen of the photometer, enables the first measurement to be made, while the tint is determined by observing this screen by means of a red glass suitably chosen.

Also, in order to avoid the errors arising from the unequal distribution of the horizontal intensity due to the position of the filament in the bulb, and to its different torsion in different lamps, M. Crova proposed to turn the lamp on trial round on its geometrical axis.

This excellent method and these indications, which would certainly correct the photometric measurement, and render the various results more capable of being compared, have not, as far as we know, been applied in practice; their application is too complicated, and takes up too much time for each lamp. The luminous power indicated on the lamps represents more or less approximately the value of the mean horizontal intensity; the mean spherical intensity is never indicated. As only one measurement is taken for each lamp, a certain fixed position is agreed upon for this measurement; thus the lamp is always placed in such a position, that the plane passing through the two branches of the filament shall be parallel to the plane of the photometric screen. With the horseshoe filaments this condition is of considerable importance, for at 90° from this position one branch of the filament would be completely hidden by the other. For the looped filaments the difference is not so great, but not to be disregarded. When the filaments have a rectangular or oval section, instead of a circular one, the measurements must be made in different positions, in order to obtain an approximate value of the mean horizontal intensity, unless the lamp is turned round, as M. Crova suggests.

We will briefly describe the mode of procedure adopted in lamp factories for photometric measurements. Three persons are required for this operation. The first, by means of the rheostat, of which we have already spoken, brings the lamp to the point required, and makes the photometric observation; he must be protected by large screens on each side, so that in no case can his eyes be affected by the strong light of the lamp on trial, nor by that of the standard employed. The second places the lamp on the bench in a special clutch, and takes it away after the measurement, noting the constants given him by the third; to this latter is entrusted the reading of the voltmeter and ampèremeter. Here it must be observed that the voltmeter must have a very high resistance as compared with that of the lamps, and the ampèremeter an excessively low resistance; if these conditions are not observed, the readings will have to be corrected, and this is generally the case. These instruments must give rapid indications, so that the reading can be taken the moment that the first man has finished his share of the work. The current is supplied by accumulators.

### The Socketing of the Lamps.

As soon as the photometric measurements are concluded the lamps are sorted according to their standards as to voltage and luminous power; there is then generally one last operation to which they are subjected, and this is placing them in their sockets. This operation is avoided in the mounting on hooks at first adopted by Swan. This kind of mounting is now almost entirely abandoned on account of the many inconveniences involved in its use in practice; for instance, after a little while, the springs which effect the contact between the hooks of the support and the rings of the lamp lose their elasticity, the contacts become faulty, and the little arcs which form at these points render the lamp and its support useless; it often happens, also, that the tension exercised on the little rings of the lamp by the springs of the support breaks the platinum wire that conveys the current to the filament, and the lamp is spoilt.

In the supports in general use at the present day, a socket is always necessary in order to put the lamp on circuit; this is the part that has to be fixed to the lamp. The operation of socketing is slightly different, according to the type of socket used.

In all cases the following is the mode of procedure: A copper wire is soldered to each of the platinum wires protruding from the head of the lamp; these are the wires that are then soldered to the two contacts of the socket. The lamp is then capped with the socket, the two copper wires being arranged conveniently; the socket is then filled with modelling plaster mixed with a solution of gum, and the head of the lamp is embedded in the plaster. When the plaster is of good quality and carefully used, it quickly sets, and the mass becomes extremely hard. The little cavities formed in the head of the lamp when it is blown cause the plaster to adhere closely to the lamp. When the plaster is thoroughly hardened, and there is no fear of the lamp becoming detached from the socket, the workman takes the lamp, cuts the copper wires protruding from the support and solders them to the contacts. Now there is nothing to do but to clean the lamp before it is ready for use, only it must not be put in service for some days, *i.e.*, until the plaster is thoroughly dry. If this precaution is neglected, electrolysis is set up in the damp plaster; a certain absorption of the current follows, which increases the consumption of the lamp, heats the socket, and sometimes completely consumes the copper wire connecting the socket with the lamp, so that the lamp ceases to burn.

A few words, now, on the various types of socket in use. The model which is by far the most generally used is the bayonet socket, known to everybody; this is, however, not the best that has appeared, and it has even serious defects, the consequences of which fall upon the incandescence lamps for which it is used. One of the most serious objections urged against it is that it gives defective contacts, therefore it cannot be used for lamps of high intensity; moreover, the proximity of the two pieces in contact favours short circuits. But it is the simplest of all the types now in use, and consequently the cheapest; this is probably the reason of its success. We must also add that the support on which the socket is mounted is also very simple, but has defects almost as great as those of the socket. The Edison screw type, the oldest type of socket, is certainly far preferable, but its high price has caused it to be replaced in many installations by the bayonet socket.

Several other types, some of them very ingenious, such as the Gerard socket, and the Siemens socket, have been brought out since. Certain lamp makers seem to have modified the form of the socket in the hope of retaining certain customers. Most of these types are now abandoned, or only to be met with in certain districts or in certain isolated installations.

We may say that it is almost impossible now to bring out a fresh type, whatever advantages it may offer, owing to the general use of the bayonet stem and socket; the only admissible modification would be to improve the present stem, which would be very difficult, and would only half solve the question, seeing that the support cannot be touched.

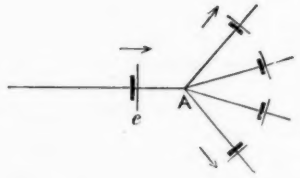
*(To be continued.)*

## A NEW ELECTRICAL THEOREM.

That a simple theorem admitting of easy proof should have hitherto escaped notice is remarkable when we consider what a running of the gauntlet is provided in the shape of scientific societies and the hundreds of eager men who are continually searching the old truths and endeavouring to find out new ones. A theorem, however, of possibly some future practical importance has been discovered and formulated by Mr. T. H. Blakesley in a paper which is published in the last issue of the *Proceedings* of the Physical Society (Vol. xiii., Part I., p. 65).

In order to state the matter briefly, the following definition is adopted by Mr. Blakesley:—If in any system of conductors, however reticulated, two or more modes of disposition of source of E.M.F. produce in every part of the same network the same current, such systems of disposition are called *equivalent systems*. Then the theorem is as follows:—If any system of conductors, possessing seats of E.M.F. at any number of points, if any of these sources be supposed to move continuously along the various bars of the conducting system, and where a point of juncture is encountered, each to become a seat of the *same* E.M.F. in *each* of the newly encountered bars (of course, leaving the resistance of the source behind), then the disposition at any moment is equivalent to that at any other moment, and, therefore, to the original disposition. [Of course, the direction of the E.M.F. must be carefully maintained the same; if it is towards the knot before crossing it, it must be away from the knot after passing it.] The proof need only refer to the passing of the knot line, for no one will doubt that if the sources only move in an *unbranching* portion of the conductor, the currents in different parts of the system will remain the same.

Let, therefore, the source, $e$, approach the point, A, at which its path splits into, $n$, other ways. In each of the $n$ bars, suppose a source, $e$, inserted as directed, then there, $n$, alone must be equivalent to the single source before reaching




A; for if the $n$ sources were reversed, the current due to these sources in every portion of the system is reduced to zero. The reversed, $n$, sources would, therefore, alone produce currents in the system equal numerically, but opposite in direction, to those produced by the single source. Hence it follows that the $n$ sources (not reversed) will produce the same current as the single source.

The principle of the superposition of currents enables us to apply this result to each source of the system, and therefore to prove the truth of the theorem in its complete generality.

In equivalent systems, since the current in every part remains the same, the total power expended remains the same; and equivalent systems might have been defined as those which produce the same expenditure of power in each part; and therefore the total power of the sources remains the same.

From the point of view of Kirchhoff's theorem $\Sigma e = \Sigma . r c$ for any closed path in a network, the above general theorem may seem to some minds even plainer and more easily proved than on the method of demonstration which I have employed. For it is plain from the method of derivation, that if a seat of electromotive force exists in any closed Kirchhoff path it can never leave it; and if in the movement of the sources one of them approaches the closed path under consideration, at the encounter it becomes in that path two equal sources acting in opposite directions.

If, therefore, $\Sigma e$ remains the same for any path and $r$ remains the same for every part, then obviously $c$ must remain the same for any portion of that path, and therefore for every part of the network.

The following propositions flow immediately from the main proposition:—

(1). If a closed continuous surface contains any region of any network, and some bar which cuts the surface contains, or by derivation as above can be made to contain, the seat of an electromotive force, then that source can be done away with without disturbing the currents in any portion of the system provided that in the other bars which cut the surface sources of electromotive force be inserted of equal value but of opposite direction as regards inside and outside of the surface; for it is clear that such sources would result from the migration of sources in one direction.

(2). If two systems of electromotive forces are equivalent, one may be derived from the other. For if system A is equivalent to system B, and we suppose $\frac{A}{2}$ to represent a distribution identical with A as regards positions, but of half the electromotive force in any case, then $\frac{A}{2} + \frac{B}{2}$ is equivalent to A or B alone. Now if any Kirchhoff path containing a source from $\frac{A}{2}$ does not also contain a source from $\frac{B}{2}$, then Kirchhoff's law would be outraged; for the sum of the electromotive forces in that path would be only half what they are from A alone, whereas the currents and resistances remain the same. Hence for every Kirchhoff path there must be equal sources from each system. Either system may now have its elements moved up to those of the other system; any resulting side branchings will be the same (though differing in sign) whether derived from $\frac{A}{2}$ or from $\frac{B}{2}$, and must necessarily produce no effect by themselves, because if we consider $\frac{B}{2}$ to be reversed, the whole effect of $\frac{A}{2}$ and $\frac{B}{2}$, *now in the same bars*, will be zero.

## THE ELECTROLYSIS AND POLARISATION OF MIXTURES OF SALTS.

According to Buff, when a mixture of two salts is electrolysed, there is always a fixed ratio between the amounts of each decomposed by the current, and this ratio is independent of the strength of the current used. Now, in 1890, L. Houllevigue (*vide Comptes Rendus*, cx., pp. 637—640) showed that this law is not strictly true, but is complicated by the probable occurrence of secondary actions, and further, that if the secondary action is supposed to be proportional to the time, the ratio should be a hyperbolic function of the intensity of the current.

In the paper referred to experiments are described in which aqueous solutions of zinc and copper sulphates were electrolysed, (1) with varying intensity of current and a constant difference of potential between the two electrodes; and (2) with constant intensity of current and varying differences of potential. With a solution which contained, per litre, 37·5 grammes of zinc and 0·968 gramme of copper, the difference of potential being 6·94 volts, a variation from 0·0165 ampère to 0·0506 ampère caused a gradual increase in the ratio Zn | Cu from 1·15 to 5·64. With 48·1 grammes of zinc and 2·30 of copper per litre, and a potential difference of 7 volts, an increase in intensity from 0·0104 ampère to 0·0·65 gave an increase in the ratio Zn | Cu from 0·74 to 1·58. It is obvious, therefore, argued Houllevigne, that the proportion between the deposited ions varies greatly with the intensity of the current, a result different from that attained by Buff with hydrochloric and sulphuric acids. It is probable, however, he considered, that the electrolysis of mixed zinc and copper sulphates is complicated by secondary reactions, and if it is assumed that Buff's law is true, but that secondary action takes place between the deposited zinc and the copper sulphate, and is proportional to the time, it can be shown that the ratio Zn | Cu should increase with the intensity of the current. With constant intensity of current,

but a difference of potential varying from 3·25 to 6·55 volts, and from 2·85 to 5·26 volts, the ratio Zn | Cu remains the same, except when the E.M.F. approaches the minimum at which brass is deposited.

In a paper published in the *Annales de Chimie et de Physique* [7], ii., p. 351, Houllevigue shows that in the electrolysis of mixtures of zinc and copper sulphates, the ratio Zn | Cu deposited does actually increase with the current, and is a hyperbolic function of the intensity. Buff's law, therefore, is only approximately true when the intensity of the current is sufficiently great.

When mixtures of variable composition are electrolysed, Houllevigue finds that the weight decomposed of the more readily electrolysable constituent increases regularly with the amount in which it is added to the mixture, except when the total amount present is very small. Thus, if to a fixed amount of zinc sulphate, copper sulphate is added in amounts which increase in arithmetical progression, and the mixtures are electrolysed under comparable conditions, the weight of copper deposited also increases in arithmetical progression.

The polarisation produced in a mixture of two salts depends upon the nature of the constituents, even when only one of them would undergo electrolysis. It diminishes in proportion to the weight of the more electrolysable constituent introduced into the mixture, except when the actual amount present is but small. Houllevigue considers that Lippmann's law of the depolarisation of an electrode placed in a mixture containing one of its own salts only holds good for very small currents.

In conclusion, Houllevigue discusses the relation which he believes to exist between the nature of the deposits produced by electrolysis and the corresponding polarisation—a relationship, by the way, which he only describes as "theoretical."

## WHAT IS ELECTRICITY?

In a recent number of the *New Science Review*, "What electricity is" is discussed by a symposium consisting of Mrs. Bloomfield Moore, Mr. Henry Clay, and Mr. C. J. Reed. Of the last writer's contribution we have nothing further to say, than that it is a very clear and sensible critique by one who understands what he is talking about.

Mrs. Bloomfield Moore, whose writings have more than once been reviewed in our pages, is an ardent apostle of the doctrines of the renowned Keely. In her present article she solves easily and gracefully the knotty problem of "What electricity is" by the help of Keely's new philosophy of sympathetic physics. That this is but a small instalment of the wonderful results to be expected from this new and powerful method of analysis, may be inferred from her opening paragraph. "Now that modern science has proclaimed from her seat of learning (at the recent annual meeting of the British Association) that it knows nothing of the great central mystery, the origin of the life—that the stupendous problems associated with the operation of the laws of nature which the highest scientific intellects have been wrestling with for several generations, are still unsolved—that the questions, 'Whence come we?' 'Why are we here?' 'Whither go we?' remain unanswered; and that if we strain our eyes to pierce the cloud of mystery which envelops these phenomena of nature, it is only to feel the conviction that it is impenetrable; that no certain knowledge can be obtained—now that science admits her abject ignorance on all these subjects, *could there be a more fitting time to make known to the world the fact that Keely's system of sympathetic vibratory physics solves these problems, answers these questions, and demonstrates in mechanics what its canons assert.*" Further on, it is stated that "sympathetic physics shows us that the ways of Deity are *not* past finding out." The claims of the method of sympathetic physics cannot be said to be modest; some would say they approach the blasphemous, and though without the assistance of the new philosophy they might have some difficulty in answering the questions, "Whence Keely comes?" and "Why he is here?" they would have none in saying "Whither he goes."

Few things will puzzle the future historian of our century so much as the success which so many barefaced frauds have met with, notwithstanding the great advance in scientific knowledge, and the universal spread of education. Spiritualism, theosophy, electropathic belts, and Keelyism, *et hoc genus omne*, will then be regarded by him much as we now look upon our ancestors' belief in witchcraft. The plain facts of nature, as revealed by patient scientific research, seem not to satisfy the popular taste, and consequently the quack who announces the discovery of mysterious forces and cures, always finds ready believers and easy victims.

Mr. Keely, according to Mrs. Bloomfield Moore, after a sufficient study of the teachings of the ancients, discovered the secret of Pythagoras—"the law of attraction and repulsion." This secret, in 1872, fructified into the invention of the "hydro-pneumatic-pulsating-vacuo engine." Notwithstanding the unwieldy length of its name, a working model of this engine appears to have been constructed and exhibited by Keely about 1878. Its performances seemed to have greatly impressed a number of persons, probably ignorant of mechanics, but the secret of its construction was always carefully withheld by Keely. A company was formed to work the invention, the shares of which rose for a time to a high premium, then fell to zero, with the result of inflicting on Mr. Keely the indignity of temporary incarceration. But as Mrs. Bloomfield Moore reminds us in this ardent defence of Keely, "the man who would bring about great changes must have an enormous belief in himself, an unbounded confidence in his cause, and a large faith in the future. All these requisites, coupled with a godlike patience, are possessed by this founder of a new school of science."

Mr. J. B. Knight, who appears from his report to be a competent engineer, examined Keely's "hydro-pnuematic-pulsating-vacuo-engine." He was told that the motor was working under the action of a vapour which was thrown into a state of vibration by passing between two discs, and which the gauge on the engine showed to have a pressure of 10,000 lbs. per square inch. Mr. Knight asked to be allowed to test the gauge, but this Keely steadily refused. He, however, incautiously supplied Mr. Knight with a sample of his vapour drawn from one of his receivers into an iron bottle. When this was examined, the bottle was found to contain atmospheric air at a pressure of 225 lbs. per square inch. Mr. Knight finally concluded that Keely's motor was worked by compressed air and vacuum prepared beforehand, and that every explanation offered of the action of the machine was at variance with known physical laws. After these rebuffs, Keely appears to have "lain low" till 1888-89, when he reappeared with another motor, or the old motor modified. Of this motor he published an illustration for the delectation of his admirers, but still kept its design a close secret. He described his machine as consisting of a disintegrator, a liberator, and a tubulator resonator. It was exhibited in motion, but none could detect the source of power. One man, it is true, who said that he had been employed by Keely as a workman in the construction of the motor, alleged that the motor was merely a triple application of the principle of the hydrostatic paradox (which has misled so many ignorant inventors), but this was promptly denied. According to Mrs. Bloomfield Moore, "in 1888 the teachings of the ancients regarding what we call electricity and magnetism were brought to Keely's notice; and taking up another line of research, he soon became convinced that the force he had discovered 14 years before, is *the third current of the triune stream of electricity or negative attraction.*" What will Dr. Lodge think of this as a modern view? "The ancients taught that these forces which we call electricity and magnetism are one and the same, and that between is a neutral force." Mr. Keely, with great metaphysical acumen, saw an objection here to the terminology of the ancients, and though, as a rule, believing in the vast superiority of the wisdom of the ancients to that of the moderns, he presumed to remark that "when a force becomes neutral it is inactive, and is no longer a force." He proposed, as a substitute for this term, "the latent neutral"—a great improvement.

Lest the great truths of Keelyism or sympathetic physics should have fallen on the blind spot of our mental retina, we offer a few extracts from Mrs. Bloomfield Moore's article, to allow our readers to judge for themselves. First as to definitions:—Definition 1. "In this system force and energy are classified as opposites, working in antagonism to each other. Force as a positive power, which initiates aggregative motion, and resists separative motion, in three postules of

ponderable matter in the etheric medium; energy as a negative power, which initiates separative motion, or disintegration, and resists aggregative motion in three postules of ponderable matter, also of the etheric medium." Apart from the context, this might be taken to have something to do with the Irish question. Definition 2. Electro-magnetism is "the law of reciprocity between electrified bodies and the magnet." Definition 3. "What Faraday called diamagnetic bodies, are bodies containing one electric force only, and consequently are not magnets in any sense of the word." If Faraday could hear this definition, three postules of ponderable matter would scarcely be sufficient to express his feelings towards Mr. Keely. Definition 4. "In electricity, the positive and negative forces are never present in the same body. In a magnet where the two forces are always present actively in one substance, the neutral appears midway in the substance, separating the two, and thus preventing their blending with and neutralising each other." This definition may, perhaps, be useful to Prof. S. P. Thompson. We do not propose to give a complete account of the system of Keely, but will merely add one proposition, and allow our readers, if they want more, to seek for it in the pages of Mrs. Bloomfield Moore:—"The path of research to attain the knowledge sought by *savants* is laid in the conditions connected with association and dissociation, electric under the latter, magnetic under the former. On the line intimated, every researcher will find it in his power to answer Pilate's question, what is truth?"

The germ of truth that underlies all Keely's jargon about sympathetic physics and sympathetic vibratory machinery, is the fact with which all physicists are perfectly familiar, that is to say a tuning fork will impart vibratory motion to another tuning fork which has the same rate of vibration by means of the waves produced in the intervening medium. In a well-known class experiment in physics, two pendulums of equal length are suspended at opposite sides of a rigid frame of wood; when one of the pendulums is set swinging it will gradually set the second pendulum a swinging by means of the minute periodic impulses transmitted through the frame. The important point, however, in this experiment, which Mr. Keely appears to have omitted to notice, or ignored, is, that as the vibrations of the second pendulum increase in energy, those of the first diminish. The laws of conservation and dissipation of energy hold here as in all other transformations. There is no creation of energy; and no transmission without paying the usual toll to friction.

This so-called principle of sympathetic vibration is, therefore, no discovery of Keely's; it has long been known under the name of resonance. The principle has received recently many important applications, and gives great promise of practical results, though not as Keely imagines, for producing motive power.

The other writer on "What Electricity is," Mr. Henry Clay also treats the question in a way that savours of Keelyism. Electricity is defined as "a new condition of energy brought into existence in the readjustment of individual atomic affinities, so that a universal or average harmony of the mass may be attained." Mr. Clay's theory of the battery and the dynamo we must quote:—

"In the generation of currents of voltaic electricity, the apparatus used is a battery containing two elements more or less metallic in their entirety; the simplest form being composed of metallic copper and zinc, in a sulphate of copper solution. These metallic elements, being connected outside of the solution by a wire, complete a circuit and form a given mass. Zinc and copper are each composed of individual atoms or molecules, and each atom absorbs the same quality of light rays as the other; hence they are equilibrated and in unison. That is, the copper atoms are not in average harmony, they are in unison; every atom of the mass of copper is in absolute harmony with every other atom. The same is the case with the atoms of zinc.

"The sulphate of copper, being a chemical resultant, has been restored to the average harmony of the mass by the energy "electricity," in proportion as its elements, sulphur and copper, may have absorbed the vibrations of light rays, for which their individual atoms had an affinity. The crystals having been deposited in water, the opposition to the average harmony is more powerful than the electrical energy can resist, and the mass disintegrates.

"The atoms of copper (which had been combined in average harmony with the sulphur) having an affinity for the copper element of the battery, are deposited thereon and become in unison therewith, while the sulphur, being a corrodent of zinc, attempts to displace the zinc element. This attempt at displacement is resisted by the atomic unison of the zinc mass, and makes a new average harmony necessary; then the new energy to restore order—electricity—becomes operative, and not being able to enter the zinc by way of the solution, because of the deposit upon its surface of oxide, it rushes as a current through the wire circuit to the zinc, and in its passage harmonises with the absorbed light rays of that portion of the mass, and slightly disturbs its atomic unison, hence resistance (and magneto-inductive action). Order is restored, however, and it reaches the zinc. And in restoring to an average harmony the atoms of the opposing zinc and sulphur, the zinc in the solution is disintegrated; a portion of its absorbed light rays escaping as hydrogen gas, and the balance being united in average harmony with the sulphur in a new mass, sulphate of zinc, whose equilibration is the colour of the quintessence of light, white.

"The operation of dynamic electricity is precisely the same. The revolution of the armature destroys the unison of the mass, and brings into inductive proximity the new condition (atomic opposition) that requires a new condition of energy—electricity—to restore the mass to an average harmony, and the greater the rapidity with which these changes occur, the greater the tension of the electrical current; so that if an apparatus can be made that can disturb the mass unison with sufficient rapidity, and restore it again before the natural equilibrator—electricity—can act, there will be drawn from the mass its life, the vibrations of light rays, and an artificial light be possible that is not the resultant of heat, but which will be similar to the Aurora Borealis."

As the great lexicographer has remarked of something similar, one could write any quantity of this sort of stuff if one would only give their mind to it.

It is to be regretted that paper and printers' ink should be wasted in putting Keely's doctrines before the public, and we should not have considered the subject of sufficient importance for notice if it were not that this sort of mystical humbug, especially if connected with electricity, appears to impose so easily on the unscientific public.

## DR. KEITH ON THE "ELECTROLYSIS" AND "ANALYSIS" OF ELEMENTARY BODIES, WITH ILLUSTRATIONS OF CRITICISM.

By DESMOND G. FITZGERALD.

That Dr. Keith should be angry is not, in itself, anything to be surprised at. In the first place, he was treated with scant courtesy at the Institution of Electrical Engineers. I think it is one of the first duties of the chairman of a meeting to introduce to the latter any comparatively unknown person who is to address it. But Dr. Keith was left under the disadvantage of not having been introduced to his audience, so that most of them were, and are, puzzled as to whether Dr. N. S. Keith is, or is not, the Keith whose name is associated with a well-known process for the refining of lead and the separation from it of silver and other more or less valuable metals. He was not, so far as I am aware, thanked by anyone,* except myself, for bringing before our Institution a paper which, directly and indirectly, has already been of some effect in augmenting the general stock of knowledge on an important and interesting method of treating certain auriferous deposits. His paper was severely condemned by another inventor who is a recognised authority on

* I see, in the report of the discussion given in the Electrical Review, that the President observed that "he did not want to be at all grudging in thanks to the author for bringing this extremely interesting matter before them."

the electro-metallurgy of gold. Then, in the second place, the comments of Mr. Andreoli were not precisely flattering; and it would appear that some of my remarks have not been taken in good part. Hence we have—not only the spectacle, fit for the Gods, of a good man in adversity—but that of an angry man attempting to *criticise* (as he calls it) *his critics*. That is an operation that was once successfully performed by Lord Byron. Nevertheless, as a general rule, experience has shown that it is better simply to reply to criticisms without endeavouring to criticise the authors of them.

But what Dr. Keith has, very unwisely, written with the above purpose in view cannot be dignified with the name of *criticism*. It is what is vulgarly termed "slogging," in conjunction with a false definition derived from a blunder on the part of a lexicographer unacquainted with electricity, an onslaught on a foreigner for what may be either an accidental omission or a *lapsus* illustrative of the comparative richness of our own language in prepositions (which is not, by the way, illustrated in the antepenultimate paragraph of Dr. Keith's letter), one or two questions which require an answer, some attempts at sarcasm so obscure that nobody appears able to understand them and one or two expressions which most gentlemen would consider to be in bad taste. And, for some reason, he has taken as his critics only Mr. Andreoli and myself, whereas, undoubtedly, his most severe and damaging critic is Mr. Vautin.

In regard to the definition of the term *electrolysis*, Dr. Keith is quite mistaken in supposing that he is free to deduce the former from the etymological derivation of the latter without any consideration of the precise sense in which the root word or words may have been taken by the originator of the term, and in which the term itself may have become universally accepted and understood. Electrolysis is certainly not the "dissolving" of a substance by means of electricity, although the Latin *solvere* may no doubt be taken as a translation of the Greek λυειν. Electrolysis is the "loosing" or "setting free" of *two* components of a compound, not of one only out of several components. The term, as defined indirectly by Faraday and directly by some of his contemporaries and successors, necessarily involves the decomposition of a binary compound, and this signification has been confirmed, and has not been in any degree modified, by the *consensus* of all electricians since Faraday's time.

It may be advisable to support this statement by a few out of the many references that could be made to more or less recognised authorities in electrical science.

Faraday ("Experimental Researches on Electricity," Vol. 1, p. 197) says:—

"I shall have occasion in these researches, also, to class bodies together according to certain relations derived from their electrical actions, and wishing to express those relations without at the same time involving the expression of any hypothetical views, I intend using the following names and terms. Many bodies are decomposed directly by the electric current, their elements being set free; these I propose to call *electrolytes* (note by Faraday:—ἠλεκτρον and λύω, solvo, N. electrolyte, V. electrolyse.) Water, therefore, is an electrolyte. The bodies which, like nitric or sulphuric acids are decomposed in a secondary manner, are not included under this term. Then, for *electro-chemically decomposed*, I shall use the term *electrolysed*, derived in the same way, and implying that the body spoken of is separated into its components under the influence of electricity; it is analogous in its sense and sound to *analyse*, which is derived in a similar manner. The term *electrolytical* will be understood at once: muriatic acid is electrolytical, boracic acid is not."

Professor W. A. Miller ("Elements of Chemistry," Vol. 1) says:—

"The process of resolving compounds into their constituents by electricity is termed electrolysis (from 'electricity' and λύσις releasing; and a body susceptible of such decomposition is called an *electrolyte*."

No. 1 of the Laws of Electrolysis is: "No elementary substance can be an electrolyte."

In Ferguson's "Electricity," p. 222 (last edition) we have: "To electrolyse signifies to decompose by electric agency."

Fleming Jenkin ("Electricity and Magnetism)," says: The compound decomposed by the electricity is called an *electrolyte*, the process of decomposition *electrolysis*, and the products of electrolysis *ions*.

In Ganot's "Physics" (10th edition p. 749), we have: "*Electrolysis* is the decomposition by the voltaic battery." Silvanus P. Thompson ("Elementary Lessons on Electricity and Magnetism"), says: "To this process of decomposing a liquid by means of an electric current Faraday gave the name of *electrolysis* (*i.e.*, electric analysis); and those substances which are capable of being thus decomposed or 'electrolysed' he terms *electrolytes*."

In Abel and Bloxam's "Handbook of Chemistry" we have: "It is found that when bodies are decomposed by a galvanic current (or, as it is termed, subjected to *electrolysis*, one of the constituents is invariably disengaged at the wire in connection with the positive pole," &c.

J. E. H. Gordon ("A Physical Treatise on Electricity and Magnetism," Vol. ii., p. 1), says: "The process of resolving compound bodies into their constituents is called *electrolysis*." "Laws of Electrolysis: *No elementary substance can be an electrolyte*. For, by definition, an elementary body is that which cannot be separated into two constituents."

George Gore, F.R.S. ("The Electrolytic Separation of Metals," p. 72), says: "Electrolysis, or electro-chemical action, is the decomposition of liquids by means of electric currents."

Hippolyte Fontaine ("Electrolyse," p. 18) says: "Faraday a donné le nom *d'electrolyse* à l'opération de décomposition par le courant."

Cadiat and Dubost ("Traité Pratique d'Electricité Industrielle," p. 13), say: "On appelle *electrolyse* la séparation d'un corps composé en ses differents éléments sous l'influence d'un courant électrique."

Houston ("Electrical Dictionary"), gives: "*Electrolysis*. Chemical decomposition effected by means of an electric current."

Webster ("International Dictionary") as quoted by Dr. Keith, gives the correct definition of electrolysis, viz: "The art or process of chemical decomposition by electricity." But he adds: "as in the electrolysis of silver or nickel in electroplating," which is obviously equivalent to: "as in the art or process of chemical decomposition of two bodies which cannot be chemically decomposed." By this unfortunate but very evident blunder—due, no doubt, to the accidental omission of the words "of solutions" after electrolysis. Dr. Keith has been misled, and, in consequence, wonders "if Mr. Andreoli's bogus Faraday, or if Mr. FitzGerald's 'Institution of Electricians,' objects to Webster's 'electrolysis of silver.'" (This is an illustration of "criticism" in the form of playful sarcasm). He also asks, what is to become of the commonly used phrase: "Analysis, or assay of gold?" My dear Sir, in the words of Prof. W. Kingdon Clifford, the expression "analysis of gold" is "wrong—always, everywhere, and for anyone." As a commercial and technical term, "assay of gold" may pass; it being understood that "fine" gold is assayed when it is found by certain tests to be pure, and that, by Act of Parliament, the term "gold" is allowed to be applied to alloys of gold containing a certain *minimum* of this metal.

Now that I have answered a question for Dr. Keith, perhaps he will do me the favour of answering one or two questions for me. He says that, in a certain number of the Electrical Review, I set forth my "*previously suppressed*" objection to the phrase or title, "The Electrolysis of Gold." I want to know *when*, *where*, *by whom*, and (if possible), *why* my objection to this expression was "suppressed." (It is suggested that the above was "wrote sarkastic," but, probably, nobody but the writer can explain to me what it means). Another question: Dr. Keith says, "I did write a lot of just such information as Mr. FitzGerald offers to your readers, but the Committee of the Institution of Electrical Engineers asked me to cut it out 'because too elementary.'" (Clever committee; how I do wish that they would open what Dr. K. would call their "knowledge box," and explain to us all the elements of the extraction of gold!) My second question is this: Did Dr. K. supply any electro-chemical order of metals, in a solution of K Cy, that would negative his own claim to the discovery that mercury is electro-negative to gold in such a solution?

I have now thoroughly "aired my confessed lack of knowledge on the *electrolysis of gold*"; but I notice that Dr. Keith holds out a hope that he may convert this *vacuum* into a *plenum* by "airing" at still greater length his positive knowledge of the subject.

C

## THE ARGON MYTH.

By J. ALFRED WANKLYN.

The more closely the papers read before the Royal Society on January 31st are examined, the plainer it becomes that the existence of anything like 1 per cent. of a new substance in the atmosphere has not been established.

In their paper of January 31st, Rayleigh and Ramsay make mention of the preparation of "argon" on the large scale; but it is quite plain that such mention is only of a hypothetical kind, and that those operators either refrained from attempting the preparation on a large scale, or, if they had attempted it, they failed to obtain the argon in quantity. The paucity of the product is amusingly illustrated by some particulars which occur in their account of the experiments. Thus, for instance, the specific gravity of the Rayleigh argon was determined—not in about 2 litres of pure argon—but upon a mixture of 400 cc. of argon with a sufficient quantity of oxygen to fill the specific gravity globe, the capacity of which was about 2 litres. And, indeed, if the reader will refer to the paper which is published in *Nature*, he will find that the total quantity of argon obtained by Rayleigh by the Cavendish process did not much exceed 400 cc. The weight of this 400 cc. is only about 10 grains, from which it may be perceived how very little has been actually obtained.

The circumstance that in Rayleigh's experiment 6·3 litres of atmospheric nitrogen yielded 65 cc. of the gaseous residue to which the name argon has been given, whilst in Ramsay's experiment a much larger quantity of nitrogen, apparently from 100 litres to 150 litres of nitrogen, were required to give 70 cc. of the gaseous residue, has been mentioned before, and is most significant. The conclusion which can hardly be resisted is that Rayleigh's argon differs from Ramsay's argon in some very essential particulars. There is a point in Rayleigh's experiment to which I would particularly call attention. The 65 cc. of gaseous residue is almost absolutely the theoretical quantity of argon called for by Rayleigh's theory that the slight difference between the density of atmospheric nitrogen and so-called "chemical" nitrogen is due to the presence of argon. Now, if the details of Rayleigh's experiment be carefully considered, it will be seen that the loss of argon due to its solubility in water must, under the circumstances of that experiment, have prevented the exhibition of more than a fraction of the total argon.

There must have been at least a litre of water in the flask employed by Rayleigh. Water, we are told, absorbs about 4 per cent. of its volume of argon, and, therefore, 40 cc. would pass into solution in the water contained by the flask. It is quite true that the solution of gases in water does not take place in an instant, but requires a considerable lapse of time; this condition is, however, complied with in Rayleigh's experiment which extended over many days, and afforded ample opportunity for the absorption to take place.

If the account of argon, which Rayleigh and Ramsay give, were correct, there ought not to have been a visible yield of more than half of the 65 cc. in the Rayleigh experiment; and the obtaining of the 65 cc. discredits the work altogether.

## CORRESPONDENCE.

### The Recent Explosions.

Having read the interesting articles on the above trouble in your recent issues, I should like to ask if it is impossible to construct a gas-tight system of conduits and manholes in the place of a ventilation system. I might suggest that a conduit constructed of galvanised W.I. pipes embedded in concrete or asphalte, with gas-tight manholes, also the ends of each pipe plugged gas-tight through which the cable passes, and the work well done, will make a lasting and sound job. I may state that I have a number of cables at work under the above conditions, having given every satisfaction since they were put in two years ago.

**Sydney L. Durell.**

### Ozone and Carbonic Acid.

In No. 902 of the Electrical Review, Mr. Andreoli has in an excellent manner explained the action of the silent electrical discharges on the carbonic acid gas which took place during the period of the production of ozone out of the air. But as the quantity of the carbonic acid gas found in the air is very small, so the presence of carbonic monoxide (C O) in the air may be considered to be of no great consequence.

Of much greater consequence is the production of nitrogenic anhydride ($N_2 O_3$) during the process of electrisation of the air. Mr. Andreoli might render a much greater service to medical science if he would kindly explain what quantity in per cent. of nitrogenic anhydride ($N_2 O_3$) is produced in the air during the process of ozonisation *in statu nascenti* of the ozone ($O_3$), and which are the best reactive materials to be used to act on the ozonised air to such end that the ozone might remain undestroyed, and the nitrogenic anhydride be absorbed. It is possible that the nitrogenic anhydride may act in a bad way on the patients subjected to ozone treatment.

**Dr. Birioukoff.**

Moscow, *March 20th*, 1895.

### Eickemeyer Patents.

In answer to your correspondent's enquiry in your issue of April 5th as to the ownership of the Eickemeyer patents for winding drum armatures, I have to state that my company is the absolute owner of these patents for the United Kingdom, and that my company alone can grant licenses for their use.

**Thomas Parker, Limited,**
Mein Wilkie, F.C.A., *Secretary.*

On page 423 of your issue of 5th inst., there is a paragraph entitled the "Eickemeyer Patents." We judge it may be of interest if the fact be known that this company are the exclusive owners of the Eickemeyer patent referred to, *so far as elevators or lifts are concerned.* Outside this field the ownership is, as you state, with Messrs. Thomas Parker, Limited.

**Otis Elevator Company, Limited,**
Wm. Augs. Gibson, *Managing Director.*

## THE ST. PANCRAS EXPLOSIONS.

8, Richmond Terrace,
Whitehall, S.W.

To the Secretary, Board of Trade.

*Report of a Committee of Members of the Royal Society and the Institution of Electrical Engineers appointed to confer with the Electrical Adviser to the Board of Trade with regard to the circumstances connected with the formation in large quantity of an Alkaline Deposit on the mains of the St. Pancras Electric Light Supply, and the presence in this deposit in some cases of the alkaline metals in an unoxidised condition.*

The Committee have held three meetings, and a *précis* of the proceedings at these meetings is attached to this report.

After taking evidence as to the present condition of the mains of the St. Pancras electric lighting system, and after receiving from Prof. Thorpe reports of analyses, made under his direction, of the chemical composition of the incrustation found on the insulators of these mains, and of the salts contained in the bearers of these insulators, the mortar and concrete of the conduits, and the adjacent soil, the Committee are of opinion that the explosions which have occurred were caused by the firing of an explosive mixture of coal gas and air by sparks caused by means of the above-mentioned incrustation.

It has been proved that sparks may be caused either by the incrustation itself acting as an imperfect electrical conductor, or by moisture coming into contact with metallic sodium or potassium, both of which metals have been found to exist within the incrustation.

These metals have been produced by the electrolytic decomposition of alkaline salts chiefly derived from the soil, and conveyed by moisture along the fibres of the wooden bearers towards the negative conductor.

To avoid a repetition of these accidents the bearers of the insulators at present in use should be replaced by other devices through which moisture is prevented from travelling, and it is recommended that the pattern of insulator in use should be changed, and a pattern adopted in which a longer insulating surface is interposed between the conductors and the bearer.

The Committee is also of opinion that it is desirable that means should be provided by which the conduits can be inspected throughout their length, so far as is necessary to detect incrustations on the insulators.

The Committee have not thought it within their province to investigate the causes of the presence of coal-gas within the electric lighting conduits, but it is obvious that this is the primary source of danger.

P. Cardew. R. E. Crompton.
Rayleigh. Alexander Siemens.
T. E. Thorpe. Alex. B. W. Kennedy.
William Crookes.

*March 22nd*, 1895.

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Precis of Proceedings of Committee.

Meetings of the Committee have been held on March 4th, 8th, and 22nd.

At the first meeting Mr. Baron, chief engineer of St. Pancras Electric Light Works, gave detailed evidence as to the deposit or incrustation on the insulators on the St. Pancras mains, from which it appears that it was first noticed about 18 months ago, and found to be alkaline—that 60 to 70 per cent. of the whole number of insulators which can be examined, *i.e.*, those in or near the street boxes, are affected by it, and that in some cases when scraped off it forms again within 24 hours. That the insulators which are supported on wood bearers at the various street boxes are those generally affected, and only in two or three cases has any incrustation been found in the intermediate insulators within the culverts, which are supported on iron brackets.

These wood bearers have become thoroughly saturated with saline moisture. They are supported at each end by being let into the brick sides of the culvert, and in some cases the end fibres of the wood may be in contact with the soil.

Mr. Baron has seen the deposit flame with a yellow sodium flame in several instances when water was dropped on to it, or when it was dropped upon wet ground.

He has also seen sparking from the negative main over the insulator to the wood bearer, and has produced the same by experiment with a solution of the material deposited.

The insulator in this test was moistened on the surface with clean water, and the wood bearer was standing in the solution. The sparks occurred in about five minutes.

The glaze on the insulator has been attacked in some cases.

He does not think that the process of salting the streets in order to melt snow has any connection with the formation of the deposit.

Mr. Miller of the Kensington and Knightsbridge Electric Lighting Company also gave evidence as to leakage from the negative main always attracting moisture, and stated that a negatively-charged cable belonging to his company laid in the subway at Kensington Court had a small fault of insulation, which apparently gave rise to a moist effloresence on the adjacent brickwork, which if brushed with the hand emitted a sort of phosphorescent light in the dark.

His company had experienced no trouble from incrustation on the insulators, but very high quality insulators of hardened glass or porcelain, and of the "double shed" pattern, were used.

In their system, every insulator used can be easily examined.

On March 6th Lord Rayleigh, Prof. Crookes and Prof. Thorpe, visited the St. Pancras mains. At a street box near the Chester Gate, Regent's Park, a piece of incrustation in a moderately hard and friable condition, about the size of a hazel nut, was taken from the negative main. This was placed on the cover of the street box and some water put on it, when it broke into flame. There appeared to be several nodules of metal, one about the size of a pea. This metal was solid.

Some flashes of sodium flame were also seen along the wood bearer as if the metal had been deposited there. The wood was saturated with moisture, especially under the negative.

This wood bearer was subsequently sent to Prof. Thorpe for examination. At the places corresponding to the position of the negative mains the wood was much blackened and carbonised, and very wet. On cutting it into six pieces, it was found that the wood was saturated with alkaline salts, which were strongly caustic near the negative main, and chiefly carbonates of potash and soda at the ends.

The soil, mortar, and concrete at this point have also been tested by Prof. Thorpe, and his analysis appears below.

At the second meeting of the Committee, Mr. Crompton produced three specimens of deposits taken from the insulators of the Southampton electric light mains. These have also been analysed by Prof. Thorpe (*see* below).

Prof. Thorpe produced an analysis (*see* below) of three samples of the deposit obtained from the St. Pancras mains. Considerable discussion took place as to the exact process by which the incrustation and the free metal were produced, and it was finally decided to have another meeting before reporting.

At the third meeting on March 22nd, further specimens from the St. Pancras mains were examined, and Prof. Thorpe's analyses were considered.

A glass insulator from the Southampton mains showing a considerable amount of deposit was also submitted. The report was then discussed and adopted.

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Analysis of Deposits obtained from Electrical Mains.

Sample from St. Pancras mains received 2nd March.

The substance had the composition

| | | |
|---|---|---|
| Caustic Soda ... | 7·69 | per cent. |
| Caustic Potash ... | 4·88 | „ |
| Sodium Carbonate ... | 34·40 | „ |
| Potassium Carbonate | 52·77 | „ |
| | 99·74 | „ (+ traces of Silica, Alumina, and Lime.) |

Three Samples from Southampton, received March 9th, 1895.

All are practically-pure sodium carbonate, with a very small admixture of potassium carbonate. The sample taken from the earthenware insulator is amorphous, and contains appreciable traces of calcium carbonate; the other two (from glass insulator and distributor) are crystalline, and free from all except adherent impurities. None of the samples contains free alkali.

Soil, Mortar, and Concrete from St. Pancras.

The aqueous extract obtained from each of these by slow percolation had an alkaline reaction (alkalinity = from ·12 to ·23 gram Na H O per 250 cubic centimetres of extract), and contained in each case compounds of sodium and potassium, the latter being present in moderately large proportion.

T. E. Thorpe.

*March 21st*, 1895.

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## LIQUID FUEL.

Our contemporary, *The Engineer*, recently combatted the claim made for oil fuel that it has, weight for weight, double the steam raising capacity of coal. But our contemporary simply bases its objections upon the chemical composition of liquid fuel, and calculates its calorific capacity at from 20,000 to 27,000 B.T.U. according to the amount of hydrogen present, this varying with different samples of oil. Though we would not claim a double efficiency for liquid fuel, we do not believe that its practical duty can be compared with coal on a basis of its chemical composition. Liquid fuel is so much easier to burn with an amount of air more closely identical with the theoretical minimum that the final effect is better: no man has had more experience of liquid fuel than Mr. Urquhart, of the Tsaritsin Railway of Russia. He says that the petroleum refuse has a theoretical evaporative effect of 16·2, while coal has an effect of 12·2 only. Hence, nominally, the liquid fuel is only 33 per cent. better, but he finds that coal only gives 60 per cent. efficiency, whereas he gets 75 per cent. efficiency from liquid fuel; and, on the whole, he considers he gets from 63 to 75 per cent. more evaporation per pound of the liquid than per pound of solid fuel. We believe in most or all cases that this is found to be the case, the liquid fuel giving results in practice beyond what a mere comparison of its constituents would suppose, and our contemporary does not appear to have given this point any attention. It condemns, however, the spraying of oil by steam and suggests compressed air as perhaps more suitable for steamers to avoid the waste of fresh water at sea. We can hardly suppose, however, that the forcing of oil through fine orifices would prove very satisfactory. Tar and other coarse liquids would hardly force well through openings fine enough to give a spray effect, even if considerably heated. For thinner oils possibly such a plan might answer, but it is difficult to imagine any better system of spraying than that by steam, which in Mr. Holden's engine is practically perfect for the principle employed. Liquid fuel essentially requires a mass of heated matter in the firebox to assist its combustion, but, that and other arrangements suitable, the perfection of the result is simply marvellous.

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## CAST WELDING RAIL JOINTS.

A new process of making solid rail joints was recently reported upon in the *Street Railway Review*, of Chicago. It has the merit of novelty, and, should experience prove its durability and other qualities to be satisfactory, the prospects of its further use seem rather hopeful. The process has been introduced by the Falk Manufacturing Company, of Milwaukee, and was shown in operation at the recent Atlanta Convention, since which time three miles of track in St. Louis have been jointed by the process that had previously had simply the common single bar splice, but the track is practically new.

The outfit for the process consists, in the main, of a small foundry cupola on wheels. The whole waggon weighs 7,000 lbs. complete, with

small water-tube boiler, engine and blower, the fuel being oil regulated by the steam pressure. The cupola is suspended by a gimbal ring. The moulds to receive the cast joint piece are in halves, of cast-iron, lined with a graphite composition that can be applied with a brush to the hot mould after every 20 joints have been cast, the time occupied in relining being half-a-minute. The ends of the rails are cleaned, and if they do not butt a thin section of rail is driven in to make a close joint; then the moulds previously heated to a dull red are clamped upon the rails, a tray of sand closes the joint between the moulds below, and clay pugging closes the other cracks. By this time the rail ends are fairly warmed by the hot moulds, and they are then poured full from an ordinary two-man ladle. In ten minutes the moulds can be removed to the next joint, about a dozen sets of moulds at once being in use, and kept hot in an ordinary fire. Only alternate joints are cast-welded at a time, the other joints being made after the first set are cooled off, so that contraction stresses may be minimised.

Each joint contains 120 lbs. of metal, and it is stated that the weld is perfect round the base and lower two-thirds of the web, leaving the upper parts untouched, an advantage, should the joint fail, of leaving the rail head uninjured. As originally made, only 54 lbs. of metal was poured to each joint, and one of those placed on blocks, 2 feet apart, carried 100,000 lbs. of downward pressure.

A claim is made that some secret composition is mixed with the metal and the cost of a joint is about 12s. It is thought that if the joint proves satisfactory it will easily compete with electric welding; the initial cost of apparatus is far less and the power required is small, being simply that for a blower, while there will be no need to string along the trolley wire before the track is complete. A cupola only costs £200, that will do the work of repairs while many roads cannot afford the electric plant, and some bad joints are certain to call for renewal in either system. The Falk Company is confident of success, but if not a success they propose to paint the rail ends with another *secret* mixture and prevent the adherence of the joints, so obtaining a tightly gripping joint block free to expand or contract slightly. This sounds like trusting in providence but keeping the powder dry. Certainly a good cast block should form an admirable support for the rail ends and keep the surfaces of contiguous rails in alignment, but if rails can afford to be made continuous the electrical weld is, of course, far neater than the cast weld, though there are difficulties in applying the electrical process without the power, and the cast joint can readily be made with a plant of small cost and easy portability, irrespective of the supply of current. It seems to afford a means of laying track before the power house is complete.

## LEGAL.

### Shelfer *v.* City of London Electric Light Company, Limited, and Meux's Brewery *v.* the Same.

In the Court of Appeal on Monday, the 8th inst., Lords Justices Lindley and A. L. Smith had before them, in these cases, motions on behalf of the defendants for a stay of proceedings, pending appeals to the House of Lords.

Mr. Renshaw, Q.C., for the appellants, said that the petition to the House of Lords was lodged on the previous Saturday, and he was instructed to ask the Court to suspend the operation of the injunction until the appeals had been heard.

Lord Justice Lindley asked when that would be.

Mr. Renshaw could not say, but supposed it would be before the Long Vacation.

Lord Justice Lindley did not think there was a reasonable probability of that.

Mr. Renshaw thought there was.

Mr. Warmington for Meux's Brewery said he should ask that the applicants should give an undertaking to expedite the appeal, as he wanted the matter disposed of. The notice of motion was to stay all proceedings, but the proper notice was simply to suspend the injunction. Nothing had been done to comply with the order.

Lord Justice Smith: Have the applicants given up the steam?

Mr. Warmington said no, and his clients were suffering worse since the judgment than before.

Mr. Renshaw said his learned friend should hardly say that because his clients were asking for an injunction to restrain the applicants from doing what they were advised would very materially remedy the vibration, namely, in pulling down the archway which connected his client's premises with Sir William Rhodes's premises next door.

Lord Justice Lindley said he supposed that they could not stop the vibration without stopping work.

Mr. Waggett, who appeared for Mr. Shelfer, said the applicants had done nothing, and he was told by his client that the steam was much worse than it was before. He came prepared to resist the motion to stay proceedings altogether. He suggested that the fair way—if the Court thought of suspending the injunction—would be not only to put the applicants on terms to expedite the trial to the House of Lords, but to suspend the operation of the injunction until May 15th, when they could see what the applicants had done.

Mr. Renshwaw said that the case was not a very lengthy one to draw, and he did not think there would be any difficulty in lodging it by May 15th.

After some discussion, their Lordships said they would suspend the operation of the injunction until June 12th, on the applicants undertaking to expedite the appeal, and pay the costs of the application.

### The Cassel Gold Extracting Company's Appeal.

#### Judgment.

In the Court of Appeal No. 2, Lord Justice Smith delivered the considered judgment of the Court in the matter of the appeal from the judgment of Mr. Justice Romer in the action of the Cassel Gold Extracting Company *v.* the Cyanide Gold Recovery Syndicate, Limited. The action was brought for the infringement of patent rights for a process for treating gold in crushed ore, and for recovering gold from tailings by the process known as the cyanide process. The defendants did not at the trial deny infringement if the patent was good, but they attacked the plaintiffs' patent, and Mr. Justice Romer held that it had been anticipated, and was consequently invalid. Against that decision the plaintiff company appealed, and the appeal was argued during several days in February last.

Lord Justice Smith, after describing the nature of the invention, by means of which in South Africa, in 1893, no less than 500,000 ounces of gold had been recovered, said the defendants did not deny the utility of the invention, nor did they deny that if the patent was valid they were infringers, but they denied the validity of the patent, first on the ground that the process was old and well known to chemists and others at the date of the patent; and secondly, that the patent was bad, because the specification was too wide. It was proved that for many years prior to the date of the patent it was common knowledge that cyanide of potassium would extract gold in a finely divided condition. There was no doubt about that. This fact was contained in a paper read by Prof. Faraday in 1840, and there were patents taken out by Rae and Simpson, who obtained gold in solution and then extracted it by means of electricity. After minutely describing these patented processes, his Lordship said the defendant failed to prove that they were able to treat gold in crushed ore and in tailings so as to give any good commercial results. As to the state of knowledge prior to the date of the plaintiffs' patent., the evidence showed that it was not known to Prof. Dewar, Prof. Crookes, Sir Henry Roscoe, Lord Kelvin, and other experts, that a diluted cyanide of potassium had a selective action, and would treat gold before touching the baser metals, whilst a strong solution treated the gold and siver and baser metals at one and the same time. There was novelty and utility in the plaintiffs' invention, and in this respect their Lordships differed from Mr. Justice Romer. But on the specifications—the provisional and final—their Lordships came to the conclusion that there was disconformity between them, and that the two specifications could not be read as having the same meaning. The provisional was a claim for all solutions of cyanide of potassium, and the final was for a dilute solution. Sir Richard Webster argued that they were one and the same thing; but their Lordships held that the first claim was for any solution of cyanide, independent of its strength, and this claim being too wide, there must be judgment for the defendants.

The appeal of the plaintiff company was therefore dismissed with costs.

### Muirhead *v.* Commercial Cable Company.

On Tuesday, the 9th inst., this matter came before the Court of Appeal, consisting of Lords Justices Lindley and A. L. Smith, by way of an appeal by the defendant company from the order of Mr. Justice Wright, dated March 12th, 1895, refusing to interfere with the refusal of Master Walton, in Chambers, to tax the costs in the action.

Mr. A. J. Walters, who appeared for the appellants, said that the action was tried before Mr. Justice Kennedy, and eventually came to the Court of Appeal, when the majority of the Court reversed Mr. Justice Kennedy's decision, and ordered judgment to be entered for the defendants. The judgment was dated December 18th, 1894, and by that judgment it was ordered that the appeal by the defendants should be allowed, and the judgment of Mr. Justice Kennedy set aside, and judgment entered for the defendants with costs, together with the costs of the appeal, such costs to be paid to the defendants' solicitors on their personal undertaking to return the money should the plaintiffs' appeal to the House of Lords be successful. The learned counsel went on to say that on March 7th an appointment was taken before Master Walton to tax, and that objection being taken by Mr. Pollard on behalf of the plaintiff that the appeal to the House of Lords would probably come on before Easter, the Master made the following endorsement on the Bill:—"I think that this taxation ought to be adjourned for six weeks, when I am told the House of Lords will hear the appeal." The plaintiffs had delivered their case, but the case for the defendants was not yet filed. He (Mr. Walters) did not think it probable that the case would come on before June, and under these circumstances the defendants appealed from the Master to Mr. Justice Wright, who simply made the following order: "No order, no costs; leave to appeal."

Mr. Pollard, for the respondents, said that notwithstanding the order for costs was made on December 18th last year, the defendants did not deliver their bill of costs until March 7th last, when they got an appointment to tax for that day, and a further appointment for the 11th of the same month. At the time the defendants delivered their bill of costs (March 7th), both parties were under order to lodge their respective case in the House of Lords by April 1st, and the Master was informed by the official who attended to these matters in the House of Lords that if the cases were lodged by April 1st, the appeal would be heard within three days, because there were no arrears in the Lords. The bill would have taken several days to tax, and the Master, thinking such objection to the taxation would be certain to arise as would necessitate a review, and probably an application to the judge or to the Divisional Court, and taking into consideration the costs of the taxation, which he thought might be incurred uselessly, decided not to tax them.

In giving judgment, Lord Justice Lindley said that he was not prepared to go to the length of saying that the Master had no discretion

in the matter; on the contrary, he thought the Master had a discretion where there was no peremptory order that the costs should be taxed forthwith. In his opinion, the Master had, in the circumstances, done that which was right. Under these circumstances, the appeal must be dismissed.

Lord Justice A. L. Smith expressed himself to the same effect.

The appeal was accordingly dismissed, with costs.

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In *re* The New Zealand Electrical Syndicate, Limited.

Mr. Clare, on Tuesday last, applied to Mr. Justice Kekewich to direct the register of certain shares in the books of this company, so as to vest them in Mr. C. F. Kemp, the liquidator of the Gülcher Company. The shares originally stood in the books in the name of Pryor, as trustee for the Gülcher Company, and Pryor transferred them to the syndicate, in order to qualify Messrs. H. R. Savory and F. Williams as directors of that undertaking. The syndicate had, however, refused them registration, alleging, he understood, that there was an arrangement with the Gas and Water and General Investment Trust, by which they were entitled to representatives on the board of the New Zealand Syndicate, and that the shares were transferred by Pryor in respect of that qualification.

Mr. Bramwell Davis, Q.C., appeared for the Gas and Water Trust, as interveners opposing the present application.

Mr. Justice Kekewich adjourned the application to later in the month, to enable the notice of motion to be amended.

## BUSINESS NOTICES, &c.

**Ready.**—The Universal Electrical Directory. This directory for 1895, which is on sale at 22, Paternoster Row, by Messrs. H. Alabaster, Gatehouse & Co., contains a total of 20,958 distinct names of individuals and firms, being 2,500 more than were contained in the previous edition, and about 8,000 more than any other electrical directory published. In addition to the incorporation of new names, all have been carefully revised, much financial information has been added, the telegraphic addresses and local telephone numbers are given, and the total of pages in the work is increased by 80, making in all about 866 pages entirely of directory matter. Price 4s.

**Argentina.**—The *Financial News* correspondent in the Argentina says that the Intendente is preparing a message for presentation to the Consejo Deliberante, asking for authorisation for installing three new electric light stations for public lighting in various parts of the city.

**Bangor.**—The City Council are to receive a report from Mr. Duce, electrical engineer, as to the means and cost of an installation suitable for Bangor. A consulting engineer is to be engaged as soon as the report is received. An expert has recommended, in a report just presented, the extension of the gas works.

**Belfast.**—The Industrial Exhibition which was to be opened here yesterday was lighted throughout by electriciy, the contract being in the hands of Messrs. Coates & Son. They have supplied 1,000 incandescent lamps of 16 C.P., and 100 Crompton-Pochin arc lamps of 2,000 C.P. each. The company's engineer, Mr. Stanley Dashwood, supervised the carrying out of the installation. The following plant is in use and on show at the exhibition:—Victor Coates, steam engine and boiler; a Castle dynamo, by Messrs. Holmes, for 700 lights; engines of the Tangye, Crossley, Robey, Acme, Midland and Stockport types; also a small Dick Kerr engine, which is a sample of the engines running in the Corporation electric light works.

**Birkenhead.**—The Town Council, after considering the working plans, sections, &c., prepared by Mr. Shoolbred in connection with the central station, have decided that Mr. David Lyon, Birkenhead, should be instructed to take out quantities in connection with the erection of the chimney, for the erection of which tenders should be invited.

**Bradford.**—The Gas and Electricity Supply Committee have recommended the acceptance of the tender of Messrs. Siemens Bros. & Co., Limited, for supplying and fixing at the Electricity Works, Bolton Road, two 300-horse-power engines, each coupled with one of Siemens dynamos, for £3,980.

**Bristol.**—Regarding the failure of the light the other Sunday, it has been ascertained that the cause was connected with the low pressure cables, one of which, when the ground was opened, was found to be nearly burnt through. A local paper states that "whether it was due to a defect in the manufacture or to some severe mechanical interference when the road was lately repaired at the particular spot" has not yet been ascertained. With a view to preventing anything going wrong at the central station, the engineer's residence is to be connected therewith by telephone.

At the Town Council on Tuesday a report was presented from the Electricity Department with regard to proposed extensions of the system to supply consumers in new districts. The outlay on works, mains, &c., was put at £10,000, but it was explained by the Chairman of the Department, Mr. George Pearson, that the working expenses would be very slightly increased, for, at present, the station was equal to supplying 34,000 lamps, and only 17,000 were connected. The speaker added, as showing this, that in the month of October last the output was 28,400 units, and the cost £475; in December 48,000 units were supplied at a cost of £485.

**Burton.**—The mains are to be extended over Burton Bridge, and a portion of Ashby and Alexander Roads.

**Chester.**—The latest step at Chester in regard to the electric lighting question is the invitation accorded to about six electrical firms in the country to send in tenders, and to supply details of the system they would propose to put down. When these have been received the council will employ a competent consulting engineer to advise them in their final selection. History repeats itself at Chester! It will be interesting to note who is a *competent* consulting engineer in the eyes of the Chester Town Council. The local press states that a condition of the contract will doubtless be that the firm whose tender is accepted "must take the responsibility of maintaining their system in working order for three or four years, as was suggested by the Brush Company."

**Croydon.**—We hear that the Town Council has made arrangements with the British Thomson-Houston Company, Limited, for the installation of electric light in the district. The contract price was £15,986 which the Corporation will provide, the company working the undertaking for five years and guaranteeing the Corporation 3 per cent. on the capital. The charge will be 6d. per unit.

**Dover.**—At a recent meeting of the Council a letter was read from the Electricity Supply Company stating that current for lighting the Connaught Hall would be switched on on 3rd inst. The Chairman of the Council stated that the Corporation were not going to pay for the light. The company were to turn current on to the arc lamps on 8th inst. The Chairman remarked that the result of their application to the Board of Trade for the appointment of an inspector would doubtless be that they would have to engage one themselves. Before making the appointment it was decided to await the Board of Trade's reply.

**Ealing.**—A Local Government Board inquiry was held here the other day into the application of the District Council for sanction to borrow an additional £7,000 for electric lighting purposes.

**Eastbourne.**—The seal of the council has been affixed to the agreement between the Eastbourne Electric Light Company and the Corporation as to the laying of mains, &c., in the borough.

**Edinburgh.**—At 5 o'clock yesterday current was to be switched on in the presence of a large company. The wife of the Lord Provost was to perform the ceremony.

**Folkestone.**—The Lighting Committee have had before them at the last few meetings the question of the improved lighting of the borough. Both electricity and incandescent gas lights have received consideration, and various schemes have been before them.

**Glasgow.**—A statement has just been issued showing the cost of lighting the Corporation Galleries during the years 1893-94 and 1894-95. During the former year gas was used, and during the latter electricity. With electric arc lamps a saving of £55 was effected.

**Great Yarmouth.**—At the meeting of the Town Council on Tuesday a report from the Borough Surveyor was considered. It stated that applications had been received for 300 more lamps, making the number now applied for 3,400. The rate of applications appeared to be fully maintained, and in his opinion quite 6,000 lamps would be installed by the end of the year. That would render it absolutely necessary that extensions of the plant should be considered, as quite twelve months would elapse between the time of determining to make an extension and of the commencement of the running of the plant. The expenditure at the station during the last month was shown to be £122 12s. and the income £80 12s. 8d., showing a loss on the month's working of £40 19s. 4d.

**Halifax.** — Application is to be made to the Local Government Board for sanction to borrowing £5,000 for the completion of the original electric lighting scheme, and £5,000 for the purpose of carrying out extensions. At present there are 2,670 16-C.P. lamps connected and orders for 280 more. With the present plant it is impossible to supply more than 4,000 lamps.

**Llandrindod Wells.**—The Urban Council is inviting firms of electrical engineers to take up the electric lighting question there. The council think of obtaining the provisional order and arranging with a company to carry out the work.

**Lowestoft.**—An electric lighting scheme has been before the Town Council, the consideration of which was deferred, but on Tuesday night the offer of the gas company to fix 50 incandescent lights in existing lanterns in the principal streets of the town, for twelve months prior to entering on a permanent contract, was accepted.

**Middlesborough.**—The result of a circular sent out by the Gas Committee is to the effect that 801 persons in the town are prepared to take a supply of current in the event of a system being adopted for the town. 3,192 replies were in the negative, and from 2,181 no reply was received.

**Newington.**—On the recommendation of a committee the Vestry has decided to obtain a provisional order for lighting the district by electricity. The Vestry will thereby themselves establish a competitive system to that of the London Electric Supply Corporation. The Vestry intends to oppose the application of the County of London and Brush Provincial Company.

**Newport (Salop).**—The District Council has unanimously resolved to enquire into the desirability of acquiring the undertaking of the Gas Company, or to introduce electricity into the town. Gas is 4s. 6d. at present.

**Oystermouth.**—A scheme for the electric lighting of the parish throughout has been proposed by the District Council, and has been under discussion at more than one meeting. The parish has no gasworks of its own, gas being obtained from Swansea, which is nearly five miles distant. It is proposed to erect arc lamps along the Promenade.

**Plymouth.**—A sub-committee of the Works Committee have recommended the council to keep their electric lighting powers in their own hands, and to erect a generating station on the shores of the Cattewater. They also recommend that the heat produced by the destruction of house and other refuse could be utilised in generating electricity. They consider that a sub-committee should visit various London and provincial electric lighting stations before any decision is come to.

**Rochdale.**—The Electric Lighting Sub-Committee have reported adversely regarding the proposal to light the public buildings of the town with electricity on account of the heavy cost. The Rochdale *Star* thinks the town hall and other public buildings, as well as the Esplanade and the centre of the town certainly ought to be lighted by electricity. We think so too. It must come sooner or later, and better sooner than later.

**South Africa.**—It would seem that there are at present a number of African orders about for electrical plant. We have taken the following from the *British and South African Export Gazette*: "The Durban Roodepoort Company has ordered, through Mr. J. Hubert Davies, Johannesburgh, a single drum electric hoist, with a dynamo to work it; Mr. Davies is also supplying a 30 H.P. electrical double drum hoist, for hauling tailings to the cyanide works of the Rand Central Ore Reduction Company at the New Crœsus; the electrical plant for this mine also includes a 30-unit 500-volt dynamo and a 10-unit motor. The Roodepoort Deep Level Gold Mining Company have accepted the tender of Messrs. Reunert & Lenz for the supply of electrical plant to the mine. An estimate is to be presented to the Borough Council of the cost of lighting Kimberley by electricity. Messrs. Clarke, Chapman & Co., Gateshead, are the builders of the electric lighting and fan-driving plant on the new Bucknall liners, *Johannesburg*, *Fort Salisbury*, and *Buluwayo*. A three-throw electric ram pump is to be erected on the Van Ryn property, to yield 26,000 gallons of water per hour. All the hauling gear at the Eastleigh mine is to be worked by an electric plant. The new plant for the Roodepoort Deep Mine includes two 240 H.P. engines, by Messrs. Willans & Robinson, Limited, Thames Ditton, for driving the electric, pumping, stone-crushing, and underground haulage plants; a condensing plant with 800 square feet surface area; and a Willans engine for electric lighting."

At a public meeting recently held in Rondebosch a motion was carried in favour of constructing an electric tramway through the Municipality.

**Southport.**—On 3rd inst. there was a Local Government inquiry regarding the council's application to borrow £15,500 for electric lighting purposes. There was no opposition.

**St. George's, Southwark.**—The Vestry have passed a resolution expressing the desirability that the Board of Trade should have better control over the gas companies with a view to the prevention of leakage from their mains.

**Torquay.**—Mr. W. H. Trentham, M.I.M.E., of London, who recently reported on the question of electric lighting, proposed that the lighting be effected by 40 1,000-C.P. arc lamps in the neighbourhood of the harbour, and 3,200 C.P. for incandescent lamps. The cost of the engines, boilers, dynamos, lamps, posts, cables, &c., would amount to £4,900, and the annual cost of working would be, including interest and sinking fund at 5¾ per cent. for repayment in 25 years, £728. He estimates that the extra cost for the electric light beyond the £368 now spent per annum for gas will be £360. He suggests that the installation be somewhat increased, sufficient machinery being provided to maintain 800 16-candle-power lamps in addition to the 40 arc lamps and the incandescent lighting for the Baths Saloons. The total outlay would then be £7,986, and the annual cost of working, including coal, &c., and allowing for interest and sinking fund, would be £1,138. On the other hand there would be a revenue of not less than £866 from the private incandescent lighting at a charge of 6½d. per unit. There would then be on the credit side the following amounts: Saving in gas at Baths Saloons, £88; saving in lamps replaced by arcs, £156 11s.; saving in pier and gardens, £124; private lighting, £866; total, £1,234 11s.; showing a net profit of £96, while as steam could be supplied from this plant, at a small expenditure, for heating the baths, the installation should be credited with another £75, making a total net profit of £171 per annum. As this small number of lamps would, without doubt, be taken up in the restricted area between the Imperial and Torbay Hotels, the low pressure system might be adopted if the private lighting alone had to be considered, but as a comparatively large proportion of arc lighting is contemplated a moderate high pressure system necessitates the use of fewer dynamos, and will enable the light to be extended at small cost to any reasonable distance. As the installation would be on a reduced scale to that formerly proposed the use of the continuous current and accumulators will be more economical than an alternating system. The capital sum of £7,986 is made up as follows:—Engines, boilers, and condensers, including steam pipes, fixing, &c., £1,850; dynamos, transformers, and meters, £1,240; 40 arc lamps and posts, £1,200; street work, junction boxes, and cable, £1,275; battery, switchboard, wiring Baths Saloons, alterations to cellar, travelling crane, &c., £1,350—£6,915; contingencies at 10 per cent., £691—£7,606; engineer's fee at 5 per cent., £380—£7,986. It has been assumed that the cellars under the Baths Saloons would be utilised as a generating station. The electric lighting committee are considering the report.

**West Rainton.**—It has been decided to light West Rainton by means of oil lamps, 25 of which will be needed. Gas or electricity, it has been decided, would be "out of the question" in consequence of the expense.

**Whitechapel.**—When the Board of Works resumed the consideration of the electric lighting question, an amendment was passed by 21 votes to 11, referring the matter back to the Electric Lighting Committee. The original resolution was to proceed forthwith with the installation.

**Wigan.**—Messrs. J. Fowler & Co., have addressed a very lengthy statement to the Wigan Electric Lighting Committee as they have heard that the proposal to accept their tender for the electric lighting work is being opposed by a rival contractor on the grounds that the cost of working plant at Burton was higher than that at Burnley.

**Worcester.**—The City Council have now passed the bill of extras connected with the erection of the central station, by a majority of one (18 to 17), "without at this stage expressing any opinion as to the conduct of the surveyor."

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**A Safety Arc Lamp Standard.**—In our issue of March 29th we described a ladder climbing arrangement combined with switching gear, made by the Falkirk Iron Company. It has been brought to our notice by Messrs. George Smith & Co., of the Sun Foundry, Glasgow, that the ladder is in most respects identical with one patented by them in 1892, and described by us in May and June of the same year. Quoting from the paragraph in our issue of May 27th, 1892, we said: "The method adopted (by Messrs. Smith and Co.) is to have a simple mechanism *inside* the shaft of pillar, which, by the turn of a key or handle, or the movement of a lever outside the base, steps are shot out from the sides of the shaft sufficiently far to form a safe and strong ladder; these steps, when closed, are arranged to form part of the ornament of the shaft, or they can be made to form a part of the plain or fluted surface." It is due to Messrs. Smith that we should mention this, but it is due to ourselves to say that when we were led to describe the apparatus of the Falkirk Iron Company, we did so on the grounds that the *combination* of the ladder and the switching gear were, to us, new. Although at the moment of writing we had not Messrs. Smith's ladder arrangement before our minds we were fully aware that improved ladders for arc lamps were by no means novel.

**Aluminium.**—We understand that Mr. C. Oppermann, of 2, Wynyatt Street, Clerkenwell, keeps a stock (probably the largest in London) of this metal in ingots, sheets, rods, wire and manufactured articles. Electrical engineers, as well as others, are gradually finding how much more suitable aluminium is than any other material for a variety of purposes. As an instance, it is pointed out that name-plates of this metal constitute a lasting and conspicuous advertisement, remaining bright even when exposed to atmospheric conditions which would tarnish and render undecipherable the usual name-plate of brass.

**Business Announcements.**—With reference to our previous notice, we now learn that the business of the Wray Electrical Engineering Company at Soho Works, Thornton Road, Bradford, is taken over as and from April 1st by the Phœnix Dynamo Manufacturing Company, who will complete all existing contracts of the former company, pay and receive all debts owing by or to the same, and carry on the business of electrical engineering in all its branches in their new and enlarged works, recently specially fitted up for the purpose, at Hubert Street, Leeds Road, Bradford.

Messrs. Green & Treacher inform us that owing to the increased demands for their manufactures they are enlarging their premises at 77, Cannon Street, E.C., with the view of holding a more varied stock. They will stock all materials for electric bell and telephone work, and also small and general fittings used on electric lighting.

**Catalogues, Price Lists.**—An advance copy of the new (1895) price list of the Electrical Power Storage Company, Limited, is before us. It has been got up in most excellent style, the general setting out being most convenient. The printing, illustrating, and the paper used are also of the first class. The first page contains a note of the capital of the company and the names of the directors and other officers. There are, of course, full descriptions of the various types of E.P.S. storage batteries and detailed instructions for working them. The many columns of figures and costs which are given in tabulated form will doubtless be found of great use to battery dealers and users. There is included much information valuable to users of E.P.S. cells, under such headings as central station cells, acid, renewals, and sundries. A special item in the book is the inclusion of the Q batteries for small work; these we understand have been largely adopted by the admiralty and other bodies. The last few pages contain illustrated descriptions of the cell inspection lamp (recently described in these columns), E.P.S. cell tester, mouse trap switch, automatic current alarm, portable hand lamp, and regulating switches. The publication is a first class piece of work. There have been large reductions in the prices of this company's accumulators lately.

Messrs. Johnson & Phillips have brought out a very neatly arranged and illustrated price list of their new short-series Brockie-Pell arc lamp.

Messrs. O. Berend & Co., have sent us an illustrated price list of Koellner's patent oil filter, for which the firm have now secured the control in England. It is stated that these filters were formerly sold by another London house as the "Diamond" oil filter.

An illustrated catalogue of the "Triumph" precision lathe and other tools, for watchmakers, opticians, electricians, &c., has been brought out by Messrs. Koch & Co., of Charterhouse Buildings, E.C.

**Change of Address.**—The offices and showrooms of the New British Electric Installation Contractors, Limited, have been removed from No. 21, Broad Street, to The Avenue, Cross, Worcester, where all communications should be addressed.

**Dissolution of Partnership.**—We learn that Messrs. Edlin and Stevenson, electrical engineers, Capetown, have dissolved partnership. In future the business will be carried on by Mr. A. David Stevenson.

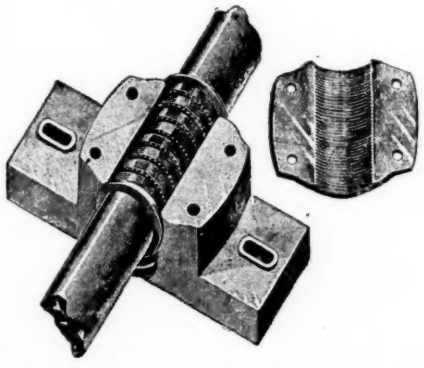
**Electric Tramway for Kidderminster.**—The Town Council has resolved that, subject to the rights and interests of the Council being properly safeguarded, favourable consideration would be given to a proposal by clients of Messrs. A. Dickenson & Co., engineers, Birmingham, to promote a provisional order for the construction of an electric tramway from Kidderminster Station to the Swan Hotel, Stourport.

**Epstein Accumulators.**—The contracts for the central station batteries for the Kensington and Knightsbridge Electric Lighting Company, Limited, at Kensington Court, and for the National Electric Supply Company, Limited, at Preston, have been placed with the Epstein Electric Accumulator Company.

**Hartlepools Electric Tramway Scheme.**—At a recent meeting of the West Hartlepool Town Council a letter was read from the General Electric Tramways Company stating that progress would be made forthwith with the reconstruction of the road-beds for the Hartlepools electric tramways, and that the lines would be equipped as early as possible. The delay, it was stated, had been occasioned by the Board of Trade not having yet given its sanction to the transfer of the trams from Mr. Moyes and Mr. Sellous to the General Electric Tramways Company.

**H. M. Salmony & Co.**—This recently established firm have taken extensive premises at 63, Charing Cross Road for offices and showrooms, with warehouse accommodation in Sandringham Buildings. Their temporary office in Basinghall Street is, in consequence, given up, but the works at Nottting Hill are continued as before.

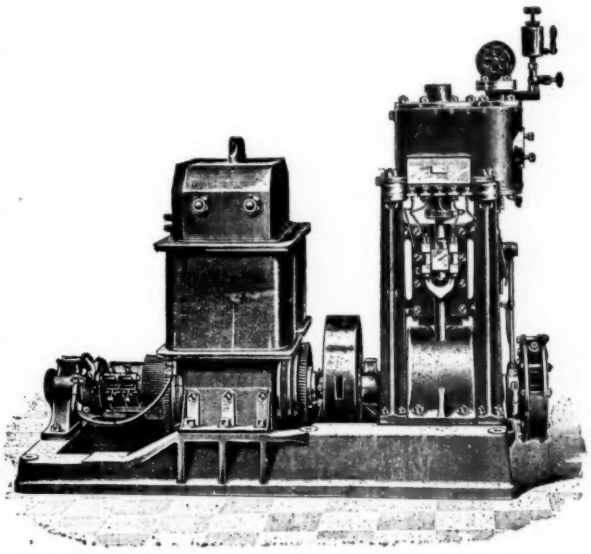
**Multiple Adjustable Ball Bearings.**—The Multiple Ball Bearing Company, of Devizes Street, N., are the makers of multiple ball bearings, and the illustration below shows the application of these to ordinary plummer blocks. The makers claim the following advantages over other kinds of bearings: Saves two-thirds of the



power; will not heat; is extremely economical in the use of lubricants; original alignment of shaft or spindle is preserved by its adjustment; the number of rows of balls being practically unlimited, it can be proportioned to stand any required duty, velocity, or pressure.

**Presentation.**—We congratulate Mr. Thomas Jenkin, the general manager of the City and South London Railway Company, upon the friendly relations that exist between himself and the staff. So far as that gentleman in particular is concerned, there was little ground for the dissatisfaction that was said to be current among certain members of the staff some time ago, for he seems to have done everything in his power to render their surroundings as satisfactory and comfortable as possible. A very enthusiastic gathering was held late one evening last week, when nearly 200 *employés* on the railway assembled to present Mr. Jenkin with a handsome writing table, suitably inscribed, and an illuminated address in recognition and commemoration of his endeavours to obtain for the company's servants an interchange of travelling privileges on all the important railway lines in the United Kingdom, so that the men and their families, who mostly hail from the country, may travel to their homes or take a holiday far away from the somewhat depressing surroundings of their daily toil in the tunnels of the Electric Railway. This arrangement will doubtless be taken advantage of by many of the *employés* at the present holiday season.

**Ship Lighting Plant.**—The combined engine and dynamo here illustrated is one of a pair recently constructed by Messrs. J. P. Hall & Co., of Oldham. The engine gives 18 I.H.P. when running at 250 revolutions per minute, with a steam pressure of 80 lbs. The dynamo is of the usual direct driving type manufactured by this firm, and is compound wound, giving at the speed stated 150 ampères at 65 volts. The armature is of the drum bar type, the driving power being transmitted to the winding by means of strong flat driving pegs let into the core which is positively driven through keys let into the shaft. The insulation is of high class quality and largely consists of mica. The commutator contains 91 segments of hard drawn copper, each being 1½ inches deep. The current density in the armature conductors is below 1,000 ampères per square inch of section, and the rise in temperature does not exceed 70° Fah. after a 10 hours' run with full load. The engine is



fitted with their new patent automatic expansion gear which gives extreme regularity of speed throughout the entire range of power of the engine. The governor can be used for either right or left hand by reversing the position of the parts. It is exceedingly compact and powerful and works exceptionally easily, there being hardly any friction, and it should run for a long time without attention or developing slack joints.

**The Britannia Company.**—This company, which is now opening an electrical department in connection with its extensive works at Colchester for all kinds of electrical work, more especially for electric lighting and transmission of power, has sent us copies of its various lists of lathes, wood working and other tools, and oil engines; also a copy of the *Tool and Machinery Register*, which gives a list of all the tools, &c., the company has for sale.

**The New Woman.**—As our readers are already aware, the British Aluminium Company, Limited, proposes to establish aluminium works in the vicinity of the Falls of Foyers, and to utilise water power from those falls. The other day there was a meeting of the residents of Stratherrich to consider the probable effects of the establishment of such works upon the district. There were present two representatives of the fair and favoured sex. With an air of self-importance and self-satisfaction, they, no doubt at great sacrifice, proceeded to this meeting to wage war against an industrial company, in the interests of the working classes of the district. These ladies were not conspicuous for their silence; indeed, so enthusiastic was one of them in her cause that she would persist in interrupting the speakers with interrogatories. Determined she was that this company should not be allowed to carry out their scheme without guaranteeing this, that, and the other absurd restriction. In short, she seemed to think the company should exist in the interests of the residents, and not for the purpose of earning dividends or building up a useful industry. It may have been that memories of Joan of Arc inspired the ladies, but happily their enthusiasm and persuasiveness were wasted, for there were no followers. They had the privilege of two amendments to themselves exclusively. We really think we must congratulate the company upon coming off victorious after such a powerful onslaught from so bold an enemy. The *Daily Chronicle* on Tuesday, in taking up the cause, published a photographic reproduction of the Falls, and considers the beauties of the neighbourhood should not be spoiled by an industrial company. We can hardly understand the *Chronicle* taking this stand, for it is greatly to the interests of the working classes of the district that these works should be established. The working classes of London and surrounding districts seldom have an opportunity to visit the falls of Foyers so they would not suffer, and these are about the only classes the *Chronicle* professes to have a care for.

## CONTRACTS OPEN AND CLOSED.

### OPEN.

**Austria.**—April 20th. The Austrian Postal Authorities in Vienna are inviting tenders for the supply of 824 tons of iron wire, and 500 kilogs. of copper wire.

**Copenhagen.**—April 16th. The Danish State Railway Authorities in Copenhagen are inviting tenders for the 14,000 rolls of Morse telegraph paper.

**Shoreditch.**—The Vestry are now advertising for tenders for the erection of electric lighting and dust utilisation plant.

CLOSED.

**Brighton.**—The Council has accepted Messrs. Crompton and Co.'s offer to supply two new armatures for the dynamos for the sum of £426. They have offered the receiver and liquidator of Messrs. Latimer Clarke, Muirhead & Co., Limited, £1,000 in settlement of all claims under the contract. Rules for the admission of visitors to the central station have been adopted.

**South Shields.**—At the council meeting held on the 3rd inst., the tender of Mr. W. H. Brown, amounting to £3,124 15s., for erecting the buildings in connection with the central station was accepted. The buildings have been designed, and the specification for the work prepared by Mr. Jeckell the borough electrical engineer, whose original estimate for the work was £3,100. Mr. Fred Rennoldson, South Shields, prepared the bills of quantities for the contractors.

## NOTES.

**Some Points in the Metallurgy of Aluminium.**—Few metals have suffered so much from its would-be friends as aluminium (or *aluminum* as our American contemporaries outrageously put it). It is to be feared that the nonsense which has been written about it has been a serious drag upon its triumphal progress. However, some metallurgists are doing more than dealing in "winged words" about this metal; and it is refreshing to come across such a piece of genuine work as Mr. G. F. Andrews has recently contributed to the American Chemical Society. After discussing the virtues and commercial values of certain alloys of aluminium with gold, silver, nickel, &c., he gives some essentially practical directions respecting the melting of the metal. He claims that the temperature should above all things be kept even, and not much above the melting point of the metal. This should be fed into the crucible in small pieces. The most useful flux hitherto discovered is pure tallow. A crucible mainly of siliceous materials must not be used, because aluminium attacks silicon. In alloying, the aluminium should be put into the crucible after the other metals have become liquid. Aluminium can be cleaned and its "mat" restored by dipping for 1¼ minute in a solution of 3 ounces of caustic soda or potash in a quart of water, then washing well, and dipping in a solution of three parts nitric acid and three parts sulphuric acid (by volume).

**Electrolytic Soda Prospects.**—To what extent the much-talked-of electrolytic process of manufacturing soda is likely to compete seriously with the established ammonia-soda process is, of course, at the present moment, merely a matter of conjecture. The electrolytic process is, comparatively speaking, in its budding youth, if not its downy infancy; and, as might be anticipated, all the side issues associated with it have neither been entirely grasped nor explored. The chief difficulty is the economical disposal of the large amount of bleaching powder which is simultaneously produced with the electrolytic soda. And the use of this substance, owing to the probable adoption generally of the electrolytic bleaching process in the manufacture of paper, textile fabrics, &c., is likely to decrease rather than to increase. Hence, as Mr. T. Ward said recently, when lecturing before the Society of Arts, the ammonia-soda process may hold its own for many years to come. We believe, however, that the end will come, for all that. The invasion of electrolytic processes into the field of manufacture hitherto held by purely chemical processes is slow, but sure. There are grave difficulties, of course, as there are in every revolution, but those which remain are not superior to those which have been already surmounted.

**The Madagascar Cable.**—On the subject of our last week's note, a correspondent says:—"The *François Arago* is to stay on the spot for six months in case of any repairs being needed. The French Government during this time pay *all* expenses and £4 a day (this is presumably the interest on the value of the ship)."

**The Storage of Energy.**—Mr. Nelson W. Perry has made the following statements in regard to his paper:—"In looking over my paper on 'The Storage of Energy, &c.,' read before the National Association at Cleveland, I find an error that does injustice to Mr. Halpin's method of steam storage. The figures were correct in my original manuscript, but got changed in the haste of transcribing the printer's copy. In the printed copy the fixed investment charges are made to add up £207 3s. 4d., whereas they add up only £164 4s. 11d. This is so palpable an error, that probably none but the casual reader would fail to detect it. It, however, places this method in a very wrong comparative light, and I will feel obliged if you will kindly call attention to the correction. Making the change, the total fixed annual cost per electrical horse-power becomes £13 19s. 2d. instead of £18 5s., and the total annual cost £20 5s. 2d. instead of £24 11s., with coal at 7s. 3d., and the total annual cost with coal at 14s. 7d. per ton becomes £23 16s. 2d., instead of £28 1s. 7d. Substituting these figures in the final comparative statement, it will read thus:—

RECAPITULATION.

| | Coal 7s. 3d. | Coal 14s. 7d. | Savings effected. Coal 7s. 3d. | Savings effected. Coal 14s. 7d. |
|---|---|---|---|---|
| | £ s. d. | £ s. d. | £ s. d. | £ s. d. |
| Present method, steady load ... ... ... | 10 2 10 | 13 13 5 | ..... | ..... |
| Present method, gas engine ... ... ... | 18 7 10 | 21 11 9 | 6 2 11 | 9 6 3 |
| Combined feed and steam storage ... ... | 19 13 5 | 23 3 11 | 4 18 2 | 7 14 3 |
| Without storage, load factor 25 per cent ... | 24 10 9 | 30 18 4 | ..... | ..... |
| Feed storage ... ... | 20 6 7 | 24 9 11 | 4 4 2 | 6 8 5 |
| Steam storage ... ... | 20 5 2 | 23 16 2 | 4 5 7 | 7 2 3 |
| Complete battery storage | 25 13 1 | 30 7 3 | −1 2 3 | +0 11 1" |

In respect to the above corrections made by Mr. Perry, Mr. Herbert Lloyd, of Philadelphia, writes to a New York contemporary, stating that he is amazed at Mr. Perry's effrontery in leaving uncorrected in this letter his figures on the results of electric storage, "when it was clearly shown at the convention that his figures were not only ridiculous, but false. For instance, Mr. Edgar, of the Boston Edison Company, owners of the largest electric storage battery plant in the world, was kind enough to publish the exact cost of this battery, and Mr. Perry's figures are 50 per cent. higher than the price Mr. Edgar's company actually paid. If Mr. Perry had been possessed of ordinary intelligence he would have understood Mr. Edgar's figures, but that not being the case, he could not distinguish between a horse-power and a horse-power-hour. Figuring batteries at a 12-hour rate of discharge, the cost per horse-power-hour is, of course, much lower than when worked at an hour and a half rate; and even when worked at an hour and a half rate, Mr, Edgar's figures were $33.33 per horse-power-hour, which would amount to about $24 per horse-power when worked at a 12-hour rate. It is a fact which cannot be disputed that batteries can be installed to-day, of central station type, for this latter figure, and why Mr. Perry should insist upon stating and re-stating figures of which he has absolutely no knowledge, I am at a loss to understand. By substituting correct figures as to first cost of storage batteries, and the cost of maintaining the same, the results obtained are as follows:—

RECAPITULATION.

| | Coal, $1.75. | Coal, $3.50. | Saving effected. Coal, $1.75. | Saving effected. Coal, $3.50. |
|---|---|---|---|---|
| Present method, steady load... | $48.68 | $65.62 | ... | ... |
| „ gas engine ... ... | 88.28 | 103.61 | $29.50 | $44.79 |
| Combined feed and steam storage ... ... ... | 94.42 | 111 35 | 23.36 | 37.05 |
| Feed storage ... ... ... | 97.58 | 117.58 | 20.20 | 30.82 |
| Without storage, load factor 25 per cent. ... ... ... | 117.78 | 148.40 | ... | ... |
| Steam storage ... ... ... | 97.24 | 114.27 | 20 54 | 34.13 |
| Complete battery storage ... | 83.19 | 100 12 | 34.59 | 48.29" |

**Electric Traction.**—At the monthly meeting of the Leeds Association of Engineers, held on March 28th, the President (Mr. S. Thornton) in the chair, Mr. Charles J. Hall, M.I.E.E., read a paper on "The Distribution of Power by Electricity." He described the advantages and disadvantages of the conduit and overhead systems for electric trams. The Roundhay tramways, he said, worked extremely well, and although the overhead wires might be considered unsightly, they could be arranged without crossing the roadway, and even be made ornamental. Posts could be placed at intervals of eighty yards, having brackets for supporting the wires just overhanging the kerb, surmounted by large electric lamps. Contact with the car would be made by means of a curved arm. This system was carried out largely on the Continent and in America, where it was common for the cars to have outside seats. The underground system was much more expensive, the repairs were costly, and the loss of electricity very great during heavy rains, more especially where the water was mixed with soot, as in Leeds. Being on too small a scale, and without a city terminus, the Roundhay tramway did not do electric haulage justice. The cost of working the Frankfort-Offenbach trams, after eleven years' running, averaged 4·6d. per car mile, the cars carrying twenty-four passengers; a very good result, considering the early date. At Halle, where the cars were drawn by horses a few years ago, the overhead wire system had been adopted. There were twenty-four cars with drivers, but no conductors. The entire working expenses equalled 2·6d. per car mile, the daily average mileage for each car being seventy. The average gross receipts for six months were £5,354 8s. The paper was illustrated by numerous tables and diagrams. A discussion followed, in which Messrs. Hartnell, Towler, Blackburn, Benton, H. Dickinson, Drake, and Burton took part.

At the Croydon County Polytechnic, on the 8th inst., Mr. C. H. Yeaman, A.Inst.E.E, delivered a lecture on "Electric Traction, with Special Reference to Traction on Common Roads." The lecturer opened his subject by a brief discussion of the reversibility of the dynamo machine. He then proceeded to describe the three types of electric traction systems, the conduit or underground, the trolley or side rail, and the accumulator or self-contained car. The different proposals which have been made from time to time on the subject of tramways were reviewed, and some reference was made to the application of electrical power to railways for long distance and high speed traction. The Heilmann locomotive and the Boynton bicycle car were instanced as being two developments along different lines, while many of the English, Continental, and American lines were incidently dealt with. The details of electric traction work, and the difficulties which have in the past beset it, were also the subject of notice, and it was shown how electrolytic troubles were got over by rail-bonding or electric welding, how powerful brakes were obtained by an adaptation of the principle of Foucalt's disc, and how the fender question was tending in America. In the second portion of the discourse Mr. Yeaman drew special attention to accumulator cars running on rails, and also those adapted for ordinary roads. The leading features of accumulators of different types were gone into, samples being before the audience, and then the use which had so far been made of the storage system was illustrated by references to the Birmingham and other tramways. The common road vehicles of Garrard, Cummings, Arnold, Radcliffe Ward, Bersey and others, were illustrated and their peculiarities dwelt upon. The lecturer regarded the future of self-contained vehicles as being a promising one, and brought his discourse to a close by a short consideration of the sanitary and commercial aspects of the problem. The lecture was copiously illustrated by experiments and lantern projection, and was received with great appreciation by a large audience.

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**Do You want Help?**—This is the title of a card emanating from the National Labour Exchange of the Salvation Army—Social Wing. The labour bureau of the Army undertakes to supply employers with all sorts and conditions of men, and amongst those on the register seeking employment we notice "electricians." It would be highly interesting to learn the names of these electricians who, from force of circumstances, we presume, have been compelled to seek help at the hands of the reformers of Darkest England.

**Dye Products by Electrolysis.**—Naphthazarin, and intermediate products related to it, may now be prepared, it seems, by means of electrolysis; and the fact is very suggestive. If one, why not all? Or, at least, a great many of those numerous substances which are now used in the important industry of dyeing? To prepare naphthazarin, a hot sulphuric acid solution of 1·1′ — dinitronaphthalene (why will these chemists squander the English language thusly?) is submitted to the action of an electric current. 1 kilogramme of the mother substance is dissolved in 20 kilogrammes of acid, and the temperature is carried to 130° C., the vessel in which the operation is performed being provided with a porous diaphragm. The cathode is immersed in the hot solution, and the anode in sulphuric acid, the diaphragm separating both. A current of 15 ampères per square diameter is passed through the containing vessel until the mother substance has been completely converted into the intermediate product. The "melt" is then allowed to cool, and is worked up into a saleable product. The process belongs to the Badische Anilin and Soda Fabrik, a company that has probably paid more fees to the Patent Office than any contemporary corporation.

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**Communication with the Canary Islands.**—The inhabitants of these islands are, at least, to be congratulated on having more than one string to their bow in the way of communication with the rest of the world. When the direct Cadiz-Teneriffe cable broke down, communication was possible *viâ* the Cape Verde Islands and Bathurst, on the West Coast of Africa, by going over a length of cable of about 4,400 miles, or about double that of the direct route. Now that this route is interrupted by the recent breakdown of the St. Vincent-St. Jago cable, the next alternative would be by way of Pernambuco and Senegal. This cable is, unfortunately, also interrupted, but a way of communication still remains by the route which encircles the whole of the Continent of Africa, and ultimately reaches Teneriffe, after passing over some 15,000 miles of submarine cable—a greater distance than from here to Australia!

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**New Patent Law for Portugal.**—Messrs. W. P. Thompson & Co. write:—"By advices just to hand we have received information that a new Patent Law has been published in Portugal which will tend to the further development of industrial enterprises in that country. We have not yet received a full text of the new law, but we find that many of the defects of the existing law are corrected, and perhaps what is of more importance to English inventors desiring to secure patents and protect their inventions in Portugal, the fees payable are much less than at present, so that the costs of obtaining a patent will be considerably reduced. Although Portugal cannot be included amongst first-class industrial countries it should not be completely overlooked by inventors, as during the last few years it has devoted considerable effort and energy towards industrial progress."

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**The St. Pancras Explosions.**—At last we have the long looked for report upon these unfortunate explosions. As it comes just as we are hurrying to press, owing to the proximity of Easter, it will be impossible to deal with it until our next issue. We note, however, with, we trust, pardonable gratification, that the joint committee have come to certain main conclusions, which differ in no way from those which we suggested as most likely to be arrived at. As regards their minor conclusions, we shall venture to say something further when we deal with the subject fully. We cannot help remarking, however, upon the meagreness of the report; the conclusions are stated, and certain recommendations made, but the reader will search in vain for all the reasons which justify them.

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**Sale of the Medical Battery Company's Effects.**—On Tuesday, 23rd inst., and three following days, Messrs. Baker & Sons will sell by auction at 52, Oxford Street, W., the whole of the electrical and other apparatus, furniture, fittings, &c., of the Medical Electrical Institute and the Electropathic and Zander Institute. Catalogues can be obtained of the auctioneers, at 11, Queen Victoria Street, E.C.

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**Erratum.**—The last word in our last week's note on "A New Phase in Consulting Work" should read *re-wired*, not *revised*.

**Obituary.**—We regret to learn that on the 18th ult. the death occurred, at New York, of Dr. P. H. Vander Weyde. The deceased gentleman was born in Holland in 1813. His attention was at different periods devoted to educational, journalistic, medical, and scientific pursuits. Mathematics and chemistry were also among the many attainments in which he excelled. Shortly after Reis invented the telephone transmitter Vander Weyde set to work to improve upon it, and in 1870 turned out instruments of his own. Quite recently he had been considering and writing upon a subject which has been much discussed in scientific journals of late, *i.e.*, "What is electricity?" He was a frequent contributor to the New York electrical press, notably our namesake.

Mr. J. H. Greener died on Sunday last, in his 66th year. He was for some years connected with the construction of telegraph lines in Ireland and the Continent. He will be more particularly remembered as inspecting engineer for stores to the India Office, and for the Crown Agents for the Colonies.

**A Cable Steamer's Rough Passage.**—It is stated on the authority of the Shanghai press that the Great Northern Telegraph steamer *Store Nordiske* met with very severe weather when on her way to Possiette Bay. The steamer was only about fifty miles from her destination when she encountered a strong northerly gale of typhoon force, accompanied by driving snow that prevented anything from being seen, and the cold was intense at the time, the thermometer indicating 40° of frost. Everything on deck was a mass of ice, and of course the steering gear was useless. In this helpless condition the steamer fell into the trough of the sea, and was in danger of capsizing, and it was only by almost superhuman exertions that she could be kept going. When the gale moderated all hands were employed to clear the vessel of ice, it being estimated that there were 150 tons weight on board, and this arduous work occupied the crew two entire days. Photographs were taken of the *Store Nordiske* when the gale abated which gave an excellent view of the extraordinary conditions in which she was placed.

**The Institution of Electrical Engineers.**—In consequence of the exigencies of their building operations, the Council of the Institution of Civil Engineers have been compelled to place the whole of their premises in the contractors hands, and no further meetings can, therefore, be held there for some considerable time. The Institution of Electrical Engineers have consequently obtained permission to hold the remaining three meetings of their session, viz., on April 25th, May 9th and 23rd, at the Society of Arts, John Street, Adelphi.

**Lectures.**—A lecture on "Electricity" was delivered at the Hull Deaf and Dumb Institution by Mr. J. W. Webster on 1st inst.

At last week's meeting of the Liverpool Engineering Society, a paper was read on "A Scheme for the Distribution of Energy in Towns," the joint authors being Mr. F. G. Baily, M.A., and Dr. C. A. Kohn.

A lecture was given on 8th inst. at the Sheffield Central Higher School, by Mr. C. L. Eclair-Heath, on "Some Applications of Electricity to Industrial Purposes."

**Cable Matters.**—The Spanish Government has decided to order an inquiry to be made regarding the construction of a direct telegraph line between the French frontier and Cadiz, giving France direct and rapid communication with Senegal and South America. The cable with the Canaries is now restored. The steamer *Dacia* has left for Senegal to repair the cable between St. Louis and Pernambuco.

**Receiving Order.**—A receiving order in Bankruptcy was granted on April 3rd in the case of H. J. Kelly, manufacturer of electric light fittings, of 58, Bread Street, E.C., and 43, King's Road, Kentish Town.

**Liverpool Corporation and the Electric Light Works.**—We understand that the Corporation Committee have resolved that £400,000 should be offered to the Liverpool Electric Supply Company for their undertaking. This decision we learn was not unanimous.

**Hampstead Electric Lighting Affairs.**—Those who have lately watched the course of affairs at Hampstead, will be interested to know that Mr. Chattock, the vestry's electrical engineer, has sent in his resignation, having been offered a much better position in the City of London, which he has accepted.

**Leicester Central Station.**—The Chairman of the Gas and Electric Lighting Committee is inviting a company of gentlemen to attend the formal opening of, and inspect, the electric lighting station at Aylestone Road, on Thursday, April 25th.

**The Northern Society of Electrical Engineers.**—At the ballot for new members and associates on 8th inst., the following were elected members:—A. F. Ellis, Corporation electrical engineer, Southport; F. W. Page, Clarendon Chambers, St. Ann's Square, Manchester; J. Sambidge, J. H. Holmes & Co., Newcastle-on-Tyne. Associate: J. A. Ormerod, R. Haworth & Co., Salford.

**Marriage.**—On Saturday, 6th inst., at St. Mary Abbot's, Kensington, Mr. W. B. Esson was married to Mrs. L. V. Fairfax. A large number of the friends of the bride and bridegroom were present to witness the ceremony, and a reception was afterwards held at the Kensington Palace Hotel, De Vere Gardens, at which was to be seen a goodly sprinkling of electrical men.

**Medical Electrical Institute.**—On 23rd inst., at 11 a.m. and 12 noon, respectively, there are to be held meetings of the creditors and contributors at 33, Carey Street, Lincoln's Inn, W.C.

**Cooking and Heating by Electricity.**—*St. Paul's*, which is this week full of good things, contains a very appreciative interview with Mr. H. J. Dowsing, of Messrs. Crompton, on "The Value of Cooking and Heating by Electricity."

**Edinburgh Telephones.**—The Town Council had before them the other day, a recommendation of the Lord Provosts' Committee to apply to the Board of Trade for a license to establish a system of telephonic intercommunication. After a long discussion, the Council approved generally of the Committee's report, and adjourned it for further consideration.

**Thermal Storage in Electric Light Stations.**—We understand that the St. James's and Pall Mall Electric Light Company are at present making arrangements to use thermal storage at their station.

## NEW COMPANY REGISTERED.

**Telautograph Company, Limited** (43,775).—This company was registered on April 5th with a capital of £42,000, in £1 shares (16,000 preference), to enter into an agreement with the Gray European Telautograph Company, and to carry on the business of telautograph, telephone, telegraph and electric light, heat and power supply company. The subscribers (with one share each) are:—F. V. Fittock, 67, Warwick Road, S.W., barrister; A. R. Walford, 112, Camberwell Road, S.E., clerk; E. Devonshire, Purbright, Chislehurst, engineer; W. List, 64, Lorrimore Street, S.E., clerk; F. W. Cushing, 13, Victoria Street, S.W., electrical engineer; C. P. Freat, 13, Victoria Street, S.W., contractor; L. O. McPherson, 13, Victoria Street, S.W., electrical engineer. The number of directors is not to be less than two, nor more than eight; the subscribers are to appoint the first. Qualification £300. Remuneration £100 each per annum, and £50 extra for the chairman, to be doubled when the profits for a year have reached £2,500. Registered by Faithfull and Owen, 11, Victoria Street, S.W.

## OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

**Universal Arc Lamp Syndicate, Limited** (36,839).—The annual return of this company was filed on March 8th. The capital is £3,000 in £1 shares. 2,865 shares have been taken up, and 2s. per share called. £277 10s. has been paid, and £22 10s. still remains to come in. Some of the shares have been paid for in full.

**Scottish House-to-House Electricity Co., Limited** (29,232).—The registered address of this concern is now situate at 49, Queen Victoria Street, E.C., having been removed from 14, Sherborne Lane, King William Street, E.C.

**Rugby School Electric Lighting Company, Limited** (39,309).—The annual return of this company was filed on March 13th, when 70 shares were taken up out of a capital of £5,500 in £50 shares. £40 per share has been called, and £2,800 has been paid.

**R. Waygood & Co., Limited** (42,679).—The statutory return of this company was filed on December 24th last, when 10 ordinary shares were taken up out of a capital of £60,000 in 3,000 ordinary and 3,000 preference shares of £10 each. The full amount per share has been called and paid.

**Anglo-American Telegraph Company, Limited** (2,891 C).—The annual return of this company was filed on March 23rd, when the whole of the £7,000,000 stock was taken up and fully paid.

**Weymersch Electric Battery Syndicate, Limited** (32,858).—The annual return of this company was filed on March 20th, and the whole of the capital, £20,000 in £5 shares, was taken up on that date. Of this, 3,000 shares were issued as fully paid, and £5,000 has been paid in respect of the remainder.

**Northern Electric Wire and Cable Manufacturing Company, Limited** (29,199).—The registered office of this company has been removed from 20, Tanfield Chambers, Hustlergate, Bradford, to Alma Chambers, 18, Horton Road, Bradford.

**Wrexham and District Electric Supply Company, Limited** (30,449).—The annual return of this company was filed on March 16th. The capital is £20,000 in £5 shares, and 115 have been taken up. The full amount has been called and £257 paid, leaving £318 still unpaid.

**Northampton Electric Light and Power Company, Limited** (28,640).—The annual return of this company was filed on March 30th. The capital is £50,000 in £1 shares (of which 10 are "A" and the rest "B"). All the former, and 13,200 of the latter have been taken up, and nothing has been called on the "A" shares, while the full amount has been called and paid on the others.

## CITY NOTES.

The Southampton Electric Light and Power Company.

We published last week the directors' report, from which it will be seen that steady progress had been maintained so far as the revenue was concerned. The revenue had increased from £1,606 14s. 8d. in 1893 to £2,491 6s. 7d. in 1894. This increase (some £880) has been obtained with an increase of £550 in expenses. The directors have been able to pay a small dividend of 2½ per cent. on the ordinary shares, and carry a small sum forward. In some respects the cost of production per unit is a trifle higher than it was last year; for instance, the cost of coal has been slightly enhanced, it standing at 1·33d. against 1·21d. It is due to Mr. Lee, the engineer, however, to mention that the company has had to pay on an average 3s. more per ton for coal than in 1893. And the fact that since February, 1894, they have had to supply at any hour of the day or night, current to two electric cranes which require a 100 I.H.P. engine and dynamo to be specially reserved for them, may have had some considerable effect on the cost, indeed we understand that on the lighting circuits they sold 550 units per I.H.P. and on the crane work only 88 units per I.H.P. No doubt this may be urged against the increased cost, but it argues rather against the paying properties of electric cranes when placed on separate circuits. The increase of management is accounted for by the fact that in 1893 the directors took no fees.

Before completing our comments we should like to point out that in the "statement of electricity generated, sold, &c.," which by the way is much fuller than electricity supply companies usually give, the quantity unaccounted for is exceptionally high, it being sixteen per cent. of the total output of the works. This is of course not likely to be due to any fault in working the system, it reflects rather upon the original design. The analysis is as follows:—

| | 1892. | 1893. | 1894. |
|---|---|---|---|
| Total capital expended ... | — | £13,607 | £17,395 |
| Number of units sold ... ... | — | 53,848 | 85,501 |
| Number of lamps connected ... | — | 3,162 | 5,396 |
| Revenue from sale of current... | — | £1,585 | £2,417 |
| Net revenue ... ... ... | — | — | £815 |
| Average price obtained per unit | — | — | 6·79d. |

| Cost of Production. | £ | s. | d. | Per unit. |
|---|---|---|---|---|
| Coal .. .. .. .. .. | 476 | 0 | 0 | 1·34d. |
| Oil, waste, water, and engine room stores | 80 | 0 | 0 | ·22d. |
| Salaries and wages at generating station | 505 | 0 | 0 | 1·42d. |
| Repairs and maintenance of buildings, engines, boilers, dynamos, &c. | 155 | 0 | 0 | (Works' cost) 3·42d. ·44d. |
| Rates and taxes .. .. .. .. | 83 | 0 | 0 | ·23d. |
| Management expenses, directors' remuneration, salaries of managing engineer, secretary, clerks, &c., stationery and printing, general establishment charges, auditors, law charges and insurance | 281 | 0 | 0 | ·79d. |
| Depreciation of buildings and plant account .. .. .. .. .. | 100 | 0 | 0 | ·28d. |
| Renewal fund account .. .. .. | — | | | — |
| Total | £1,680 | 0 | 0 | 4·72d. |

| Revenue. | | | | Average price obtained per unit. |
|---|---|---|---|---|
| By sale of current .. .. .. | £2,417 | 9 | 2 | 6·79d. |
| Meter rents .. .. .. .. | 56 | 8 | 9 | — |
| Sale of lamps .. .. .. .. | 3 | 0 | 0 | — |
| Total | £2,476 | 17 | 11 | 6·79d. |

Total cost per unit (exclusive of depreciation and renewal accounts), 4·44d.; works' cost, 3·42d.

**The Sheffield Electric Light and Power Co., Ltd.**—The fourth annual meeting of this company was held at the Cutlers' Hall, Sheffield, on the 3rd inst. Mr. Alderman G. Franklin, who presided, went very fully into the accounts, and in speaking of the prospects of the company, said they were good, and thought that shareholders would be satisfied with the efforts of the directors.

**The Great Northern Telegraph Company of Copenhagen.**—The net receipts during 1894, including the balance brought forward from 1893, amount to £307,476 8s. 9d. Deducting £47,527 15s. 6d. towards interest on, and amortisation of, debentures and interim dividends (already paid) £75,000, the board propose to distribute the balance as follows:—Extra dividend (making the total dividend for the year about 8·60 per cent.), £54,166 13s. 4d.; reserve and renewal fund, £83,333 6s. 8d.; pension fund of the staff, £2,777 15s. 7d.; directors' remuneration, £1,500; balance to be carried forward, £43,170 17s. 8d.

**Anglo-American Telegraph Company, Limited.**—The directors have resolved, after placing £6,000 to the credit of the renewal fund, to declare an interim dividend for the quarter ending March 31st, 1895, of 10s. per cent. on the ordinary stock and £1 per cent. on the preferred stock, less income-tax, payable on May 1st to the stockholders registered on the books of the company on April 1st, 1895.

**The Indo-European Telegraph Company, Limited.**—The directors, after adding £10,000 to the reserve fund, have determined, subject to audit, to recommend the payment of a dividend for the six months ended December 1st, 1894, of 17s. 6d. per share, making with the interim dividend already paid, 6 per cent. and a bonus of 20s. per share, both free of income-tax, making in all 10 per cent. for the year. The dividend and bonus will be payable on and after May 1st next.

**Richmond (Surrey) Electric Light and Power Company.**—At a meeting of shareholders on 9th inst., the following directors were elected: Mr. F. W. Reynolds (director of the City of London Electric Lighting Company), chairman; Mr. W. C. Braithwaite (director of the County of London and Brush Provincial Electric Lighting Company); Chevalier Soares. At a subsequent meeting of the directors, Mr. A. J. Lawson was appointed engineer and manager, and Mr. G. A. Luke secretary, *pro tem.* Mr. Percy W. Northey remains resident engineer.

**Stock Exchange Announcements.**—The Stock Exchange Committee has appointed a special settling day as under:—Tuesday, April 16th, Westminster Electric Supply Company, Limited, further issue of 8,000 ordinary shares of £5 each, £2 paid, Nos. 60,001 to 68,000, and ordered the same securities to be quoted in the Official List.

**Oriental Telephone and Electric Company, Limited.**—The directors have resolved to recommend to the shareholders, subject to final audit of the accounts, a dividend for the period from the date of the reconstruction of the company, viz., March 12th to December 31st last, at the rate of 4¼ per cent. per annum, free of income tax.

## TRAFFIC RECEIPTS.

**The City and South London Railway Company.** The receipts for the week ending April 7th, 1895, amounted to £935; week ending April 8th, 1894, £852; increase, £83; total receipts for half-year, 1895, £13,583; corresponding period, 1894, £12,887; increase, £696.

The Great Northern Telegraph Company. The traffic receipts in March, 1895, were £23,600; January 1st to March 31st, 1895, £68,000; corresponding months, 1894, £63,000; corresponding months, 1893, £63,200.

The Liverpool Overhead Railway Company. The traffic receipts of this railway for the week ending April 7th, 1895, amounted to £1,024; corresponding week last year, £691.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending April 5th, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £3,116.

# SHARE LIST OF ELECTRICAL COMPANIES.

## TELEGRAPH AND TELEPHONE COMPANIES.

| Present issue | NAME. | Stock or Share. ‡ | Dividends for the last three years. 1892. | 1893. | 1894. | Closing Quotation April 3rd. | Closing Quotation, April 9th. | Business done during week ended April 9th, 1895. Highest. | Lowest |
|---|---|---|---|---|---|---|---|---|---|
| 173,400*l* | African Direct Teleg., Ltd., 4 % Deb. ... ... ... | 100 | ... | 4 % | 4 % | 101 —104 | 101 —104 | ... | ... |
| 1,012,880*l* | Anglo-American Teleg., Ltd. ... ... ... ... ... | Stock | £2 15s. | £2 11s. | £2 2s. | 41 — 42 | 41 — 43 | 41 | ... |
| 2,993,560*l* | Do. do. 6 % Pref. ... ... ... ... ... | Stock | £5 10s. | £5 2s. | £4 4s. | 78 — 79 | 78½ — 79½ | 79½ | 78 |
| 2,993,560*l* | Do. do. Defd. ... ... ... ... ... ... | Stock | ... | ... | ... | 6¼ — 7 | 6¼ — 7 | 6¾ | 6¼ |
| 130,000 | Brazilian Submarine Teleg., Ltd. ... ... ... ... | 10 | 6½ % § | 6½ % § | ... | 12 — 12½ | 12 — 12½ | 12½ | 12⅛ |
| 75,000*l* | Do. do. 5 %, repayable June 1906 ... ... | 100 | 5 % | 5 % | ... | 109 —113 | 109 —113 | ... | ... |
| 44,000 | Chili Telep., Ltd., Nos. 1 to 40,000 ... ... ... ... | 5 | 10% ‖ § | ... § | ... | 3 — 4 | 3 — 4 | ... | ... |
| 10,000,000$ | Commercial Cable Co. ... ... ... ... ... ... | $100 | 7 % | 7 % | 7 % | 148 —152 | 148 —152 | ... | ... |
| 224,850 | Consolidated Telep. Const. and Main., Ltd. ... ... | 10/- | 2 % § | 2 % § | ... | 1/16 — 3/16 | 1/16 — 3/16 | ⅛ | ... |
| 16,000 | Cuba Teleg., Ltd. ... ... ... ... ... ... | 10 | 8 % | 8 % | 8 % | 13 — 14 | 13 — 14 | ... | ... |
| 6,000 | Do. 10 % Pref. ... ... ... ... ... ... | 10 | 10 % | 10 % | 10 % | 20 — 21 | 20 — 21 | ... | ... |
| 12,931 | Direct Spanish Teleg., Ltd., £4 paid ... ... ... | 5 | 4 % | 4 % | 4 % | 4 — 4½ | 4 — 4½ | ... | ... |
| 6,000 | Do. do. 10 % Pref. ... ... ... ... | 5 | 10 % | 10 % | 10 % | 9½ — 10 | 9½ — 10 | ... | ... |
| 30,000*l* | Do. do. 4½ % Debs. of £50, Nos. 1 to 1,600 | ... | ... | ... | 4½ % | 103 —106% | 103 —106% | ... | ... |
| 60,710 | Direct United States Cable, Ltd., 1877 ... ... ... | 20 | 3½ % § | 2⅝ % § | 2 % | 8½ — 9 | 8½ — 9 | 9 | 8⅝ |
| 400,000 | Eastern Teleg., Ltd., Nos. 1 to 400,000 ... ... ... | 10 | 6½ % § | 6½ % § | ... | 16½ — 16⅝ | 16½ — 16⅝ | 16½ | 16 5/16 |
| 70,000 | Do. 6 % Pref. ... ... ... ... ... | 10 | 6 % § | 6 % § | ... | 17½ — 17⅝ | 17½ — 17⅝ | 17 5/16 | ... |
| 102,100*l* | Do. 5 % Debs., repay. August, 1899 ... ... | 100 | 5 % | 5 % | ... | 105 —108 | 105 —108 | ... | ... |
| 1,297,837*l* | Do. 4 % Mort. Deb. ... ... ... ... | Stock | 4 % | 4 % | ... | 124 —127 | 124 —127 | 126½ | 124½ |
| 250,000 | Eastern Extension, Australasia and China Teleg., Ltd. ... | 10 | 7 % | 7 % | 7 % | 17½ — 17⅝ | 17½ — 17⅝ | 17⅝ | 17⅛ |
| 54,100*l* | { Do. 5 % (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326 } | 100 | 5 % | 5 % | 5 % | 103 —107 | 103 —107 | ... | ... |
| 194,300*l* | Do. do. Bearer, 1,050—3,975 and 4,327—6,400 | 100 | 5 % | 5 % | 5 % | 104 —107 | 104 —107 | ... | ... |
| 320,000*l* | Do. 4 % Deb. Stock ... ... ... ... ... | Stock | 4 % | 4 % | 4 % | 123 —126 | 123 —126 | 125¾ | ... |
| 95,100*l* | { Eastern and South African Teleg., Ltd., 5 % Mort. Deb. 1900 redeem. ann. drgs., Reg. Nos. 1 to 2,343 } | 100 | 5 % | 5 % | ... | 103 —107 | 103 —107 | ... | ... |
| 129,100*l* | Do. do. do. to bearer, 2,344 to 5,500 | ... | 5 % | 5 % | ... | 104 —107 | 104 —107 | ... | ... |
| 300,000*l* | Do. 4 % Mort. Debs. Nos. 1 to 2,016, red. 1909 | 100 | 4 % | 4 % | ... | 106 —109 | 106 —109 | ... | ... |
| 200,000*l* | Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1 to 8,000 | 25 | 4 % | 4 % | ... | 112 —115% | 112 —115% | ... | ... |
| 180,227 | Globe Telegraph and Trust, Ltd. ... ... ... ... | 10 | 4⅜ % § | 4⅜ % § | ... | 9⅞ — 10⅛ | 9⅞ — 10⅛ | 10 1/16 | 9 15/16 |
| 180,042 | Do. do. 6 % Pref. ... ... ... | 10 | 6 % § | 6 % § | ... | 16⅝ — 16⅞ | 16⅝ — 16⅞ | 16¾ | 16⅝ |
| 150,000 | Great Northern Teleg. Company of Copenhagen ... ... | 10 | 8⅜ % § | 8⅜ % | 8⅜ % | 21⅜ — 22¼ | 21⅜ — 22¼ | ... | ... |
| 190,000*l* | Do. do. do. 5 % Debs. | 100 | 5 % | 5 % | 5 % | 104 —107 | 104 —107 | 106½ | ... |
| 17,000 | Indo-European Teleg., Ltd. ... ... ... ... ... | 25 | 10 % | 10 % | 10 % | 52 — 54 | 52 — 54 | ... | ... |
| 37,548 | London Platino-Brazilian Teleg., Ltd. ... ... ... | 10 | 2 % | 2½ % | ... | 5 — 7 | 5 — 7 | ... | ... |
| 100,000*l* | Do. do. 6 % Debs. ... ... | 100 | 6 % | 6 % | ... | 105 —109 | 105 —109 | ... | ... |
| 15,000 | Monte Video Teleph. Co., Ord., 1 to 15,000 ... ... | 5 | ... | ... | ... | ... — ... | ... — ... | ... | ... |
| 28,000 | Do. do. 6 % Pref., 1 to 28,000 ... ... | 5 | 6 % | 6 % | ... | 1⅛ — 2⅛ | 1⅛ — 2⅛ | ... | ... |
| 484,597 | National Teleph., Ltd., 1 to 438,984 ... ... ... | 5 | 5 % § | 5 % § | 5 % | 5¼ — 5⅜ | 5¼ — 5⅜ | 5 7/16 | 5¼ |
| 15,000 | Do. 6 % Cum. 1st Pref. ... ... ... | 10 | 6 % | 6 % | ... | 15½ — 16¼ | 15½ — 16½ | ... | ... |
| 15,000 | Do. 6 % Cum. 2nd Pref. ... ... | 10 | 6 % | 6 % | ... | 14½ — 15½ | 14½ — 15½ | ... | ... |
| 119,234 | Do. 5 % Non-cum. 3rd Pref., 1 to 90,950 | 5 | 5 % | 5 % | ... | 5⅝ — 5⅞ | 5⅝ — 5⅞ | 5⅞ | 5⅝ |
| 1,100,000*l* | Do. 3½ % Deb. Stock Red. ... ... | ... | 3½ % | 3½ % | ... | 104 —106 | 104 — 106 | 105½ | 104½ |
| 48,800 | New Teleph., Ltd., 25,901 to 74,700; £4 paid ... ... | 10 | ... | ... | ... | ... — ... | ... — ... | ... | ... |
| 171,504 | Oriental Teleph. & Elec., Ltd., Nos. 1 to 171,504, fully paid | 1 | ... | ... | ... | 9/16 — 11/16 | 9/16 — 11/16 | ... | ... |
| 100,000*l* | Pacific and European Tel., Ltd 4 % Guar. Debs, 1 to 1,000 | 100 | 4 % | 4 % | 4 % | 105 —108 | 105 —108 | ... | ... |
| 11,839 | Reuter's Ltd. ... ... ... ... ... ... ... | 8 | 5 % | 0 % | ... | 4 — 5 | 4 — 5 | ... | ... |
| 3,381 | Submarine Cables Trust ... ... ... ... ... | Cert. | ... | ... | ... | 119 —124 | 121 —126 | 122½ | ... |
| 58,000 | United River Plate Teleph., Ltd. ... ... ... ... | 5 | ... | ... | ... | 1 — 2 | 1 — 2 | ... | ... |
| 146,733*l* | Do. do. 5 % Debs. ... ... ... | Stock | 5 % | 5 % | 5 % | 85 — 90 | 85 — 90 | ... | ... |
| 15,609 | West African Teleg., Ltd., 7,501 to 23,109 ... ... ... | 10 | .. | 0 % | ... | 4 — 5 | 4 — 5 | ... | ... |
| 238,300*l* | Do. do. do. 5 % Debs. ... ... ... | 100 | 5 % | 5 % | ... | 101 —104 | 101 —104 | ... | ... |
| 30,000 | West Coast of America Teleg., Ltd. ... ... ... ... | 10 | ... | ... | ... | 1½ — 2½ | 1½ — 2½ | ... | ... |
| 150,000*l* | Do. do. do. 8 % Debs., repay. 1902 | 100 | 8 % | 8 % | ... | 98 —103 | 98 —103 | ... | ... |
| 64,245 | Western and Brazilian Teleg., Ltd. ... ... ... ... | 15 | 2½ % | 2½ % | 3½ % | 10 — 10⅛ | 10 — 10⅛ | ... | ... |
| 33,129 | Do. do. do. 5 % Cum. Pref. ... | 7½ | 5 % | 5 % | 5 % | 6½ — 6⅝ | 6½ — 6⅝ | ... | ... |
| 33,129 | Do. do. do. 5 % Def. ... ... | 7½ | ... | ... | ... | 4 — 4½ | 3⅞ — 4¼ | 4 | ... |
| 171,900*l* | Do. do. do. 6 % Debs. "A," 1910 ... | 100 | 6 % | 6 % | 6 % | 101 —105 | 101 —105 | 101½ | ... |
| 214,800*l* | Do. 6 % Mort. Debs., series "B," red. Feb. 1910 | 100 | 6 % | 6 % | 6 % | 101 —105 | 101 —105 | ... | ... |
| 88,321 | West India and Panama Teleg., Ltd. ... ... ... | 10 | ⅛ % | ⅜ % | ⅜ % | 7/8 — 1⅛ | 7/8 — 1⅛ | 1⅛ | 1 1/16 |
| 34,563 | Do. do. do. 6 % 1st Pref. ... | 10 | 6 % | 6 % | 6 % | 10¾ — 11¼ | 10¾ — 11¼ | 11¼ | 11 1/16 |
| 4,669 | Do. do. do. 6 % 2nd Pref. ... | 10 | 6 % | 6 % | 6 % | 9 — 10 | 9 — 10 | 9⅝ | ... |
| 80,000*l* | Do. do. 5 % Debs. (1917) No. 1 to 1,000 | 100 | 5 % | 5 % | 5 % | 108 —111 | 108 —111 | ... | ... |
| $1,211,000 | Western Union of U. S. Teleg., 7 % 1st Mort. Bonds ... | $1000 | 7 % | 7 % | 7 % | 115 —120 | 115 —120 | ... | ... |
| 166,900*l* | Do. do. 6 % Ster. Bonds. ... ... | 100 | 6 % | 6 % | 6 % | 101 —103 | 101 —103 | ... | ... |

## ELECTRICITY SUPPLY COMPANIES.

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 30,000 | Charing Cross and Strand Electy. Supply ... ... ... | 5 | 5 % | 4½ % | 4½ % | 5 — 5⅛ | 5 — 5½ | ... | ... |
| 40,000 | City of London Elec. Lightg. Co., Ltd., Ord. 40,001—80,000 | 10 | ... | ... | 5 % | 13 — 14 | 13 — 14 | 13⅝ | ... |
| 40,000 | Do. do. 6 % Cum. Pref., 1 to 40,000 | 10 | 6 % | 6 % | 6 % | 14⅜ — 15½ | 14⅜ — 15½ | 15 3/16 | ... |
| 100,000 | Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid | ... | 5 % | 5 % | 5 % | 133 —136 | 133 —136 | ... | ... |
| 50,000 | †Liverpool Electric Supply, all paid ... ... ... ... | 5 | 5 % | 5 % | 5½ % | 7⅜ — 7½ | 7¼ — 7⅝ | 7 9/16 | ... |
| 49,900 | *Metropolitan Electric Supply, Ltd., 101 to 50,000 | 10 | 2 % | 2½ % | ... | 10½ — 10⅝ | 10½ — 10⅝ | 10⅝ | 10⅝ |
| 100,000*l* | Do. 5% Deb., bonds of £10, £20, £40 ... ... | ... | 5 % | 5 % | ... | ... — ... | ... — ... | ... | ... |
| 150,000*l* | Do. 4½ % first mortgage debenture stock ... ... | ... | 4½ % | 4½ % | ... | 113 —120 | 118 —120 | 118½ | ... |
| 6,452 | Notting Hill Electric Lightg. Co., Ltd. ... ... ... | 10 | ... | ... | 1 % | 7¼ — 7⅜ | 7¼ — 7⅜ | ... | ... |
| 19,980 | St. James's & Pall Mall Elec. Light Co., Ltd., Ord., 101-18,780 | 5 | 7¼ % | 4½ % | 6½ % | 7½ — 8 | 7½ — 8 | ... | ... |
| 20,000 | Do. do. 7 % Pref., 20,081 to 40,080 | 5 | 7 % | 7 % | 7 % | 8½ — 9 | 8½ — 9 | 8 1/16 | ... |
| 59,900 | *Westminster Electric Supply Corp., Ord., 101 to 60,000 ... | 5 | 3½ % | 4 % | 5 % | 7½ — 8 | 7½ — 8 | ... | ... |

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.

Unless otherwise stated all shares are fully paid. ‖ Dividends paid in deferred share warrants, profits being used as capital

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

## SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

### ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL, COMPANIES.

| Present Issue. | NAME. | Stock or Share. ‡ | Dividends for the last three years. 1892. | 1893. | 1894. | Closing Quotation, April 3rd. | Closing Quotation, April 9th. | Business done during week ended April 9th, 1895. Highest. | Lowest. |
|---|---|---|---|---|---|---|---|---|---|
| 90,000 | Brush Elecl. Enging. Co., Ord., 1 to 90,000 ... ... ... | 3 | 6 % § | 6 % § | ... | 2¼ — 2⅜ | 2¼ — 2⅜ | ... | ... |
| 90,000 | Do. do. Non-cum. 6 % Pref., 1 to 90,000 | 2 | 6 % § | 6 % § | ... | 2⅜ — 2⅝ | 2⅜ — 2⅝ | 2⅜ | ... |
| 125,000£ | Do. do. 4½ % Deb. ... ... ... | Stock | 4½% | 4½% | ... | 113 —116 | 113 —116 | ... | ... |
| 630,000£ | City and South London Railway ... ... ... ... | Stock | ⅝% | ⅝% | 1¼% | 45 — 47 | 45 — 47 | ... | ... |
| 28,180 | Crompton & Co., Ltd., 7 % Cum. Pref. Shares, 1 to 28,180 | 5 | 7 % § | 7 % § | ... | 2¾ — 3¼ | 2¾ — 3¼ | ... | ... |
| 50,000£ | Do. do. 5 % 1st Mort. Debs., 1—400 of £100, and "A" 1—200 of £50 each | ... | 5 % | 5 % | 5 % | 100 —105 xd | 100 —105 | ... | ... |
| 120,000 | Electric Construction, Ltd., 1 to 120,000 ... ... ... | 2 | *nil* | *nil* | ... | ¼ — ⅛ | ¼ — ⅛ | ... | ... |
| 12,845 | Do. do. 7 % Cum. Pref., 1 to 12,845 ... | 2 | 7 % | 7 % | ... | 1⅛ — 1⅜ | 1⅛ — 1⅜ | ... | ... |
| 100,000 | Elmore's French Patent Cop. Deposg., Ltd., 1 to 66,750 ... | 2 | *nil* | *nil* | ... | ... — ... | ... — ... | ... | ... |
| 91,195 | Elmore's Patent Cop. Deposg., Ltd., 1 to 70,000 ... ... | 2 | *nil* | *nil* | ... | 1⅛ — 1⅛ | 1⅛ — 1⅛ | 1⅛ | ... |
| 69,385 | Elmore's Wire Mfg., Ltd., 1 to 69,385, issued at 1 pm. ... | 2 | *nil* | *nil* | ... | 1¼ — 1½ | 1¼ — 1½ | ... | ... |
| 20,000 | Fowler-Waring Cables, Nos. 301 to 20,300 ... ... ... | 5 | *nil* § | *nil* § | ... | ½ — 1½ | ½ — 1½ | ... | ... |
| 9,600£ | Greenwood & Batley, Ltd., 7 % Cum. Pref., 1 to 9,600 ... | 10 | 7 % | *nil* | ... | 6½ — 7½ | 6½ — 7½ | ... | ... |
| 6,837 | Henley's (W. T.) Telegraph Works, Ltd., Ord. ... ... | 10 | 5 % | 5 % | 6 % | 9½ — 10½ xd | 9½ — 10½ | ... | ... |
| 50,000 | India-Rubber, Gutta Percha and Teleg. Works, Ltd. ... | 10 | 12½% | 12½% | 10 % | 22 — 23 | 21½ — 22½ | 22⅜ | 22⅛ |
| 200,000£ | Do. do. do. 4½ % Deb., 1896 | 100 | 4½% | 4½% | 4½% | 101 —103 | 101 —103 | ... | ... |
| 37,500 | †Liverpool Overhead Railway, Ord. ... ... ... ... | 10 | ... | 1 % | 1½% | 8 7/16 — 8 9/16 | 8½ — 8⅝ | 8½ | ... |
| 6,295 | † Do. do. Pref., £10 paid ... ... | 10 | ... | 5 % | 5 % | 14 — 14½ | 14 — 14½ | ... | ... |
| | Swan United Electric Light, Ltd. ... ... ... ... | ... | 10 % § | 7½% § | ... | ... — ... | ... — ... | ... | ... |
| 37,350 | Telegraph Constn. and Maintce., Ltd. ... ... ... | 12 | 15 % | 20 % | 20 % | 39 — 41 | 39 — 41 | 40 | 39 |
| 150,000£ | Do. do. do. 5 % Bonds, red. 1899 | 100 | 5 % | 5 % | 5 % | 104 —107 | 104 —107 | ... | ... |
| 54,000 | Waterloo and City Railway, Nos. 1 to 54,000, £2 paid ... | 10 | ... | ... | ... | 2¼ — 2⅛ | 2¼ — 2⅛ | ... | ... |

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. ¶ Last dividend paid was 50% for 1890.

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

Crompton & Co.—The dividends paid on the ordinary shares (which have not a Stock Exchange quotation), are as follows: 1892—0%; 1891—7%; 1890—6%.

### LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Birmingham Electric Supply Company, Ordinary of £5 (fully paid), 5¾—6¼.
Electric Construction Corporation, 6 % Debentures, 84—87.
Electric and General Investment, shares of £5 (£1 paid), 1½—2
House-to-House Company (£5 paid), 3⅞—4.
Do. do. 7 % Preference, of £5, 7—7½.
Do. do. 6 % Debentures of £100, 107—109.
Kensington and Knightsbridge Electric Lighting Company, Limited Ordinary Shares £5 (fully paid) 7¼—7⅜; 1st Preference Cumulative 6 %, £5 (fully paid), 7—7½.
Liverpool Electric Supply, £5 (fully paid), 7¼—7½
London Electric Supply Corporation, £5 Ordinary, ⅜—½.
Queen Anne's Mansions Lighting and Heating Company, 6 % £100 Debentures, 99—101 nominal.
Yorkshire House-to-House Electricity Company, £5 Ordinary Shares fully paid, 5¼—5⅜.

**Bank rate of discount, 2 per cent. (February 22nd, 1894).**

## PROCEEDINGS OF SOCIETIES.

### Institution of Electrical Engineers.

On the Employment of the Electric Light for Railway Purposes. By W. Langdon, member. (Paper read March 28th, 1895.)

(*Continued from page* 417.)

Incandescent System.

The machines laid down for incandescent lighting are from various makers—Siemens, Edison, Hopkinson, Elwell-Parker and Holmes.

The incandescent lighting, with the exception of Derby, is on the simple parallel system. At Derby the three-wire system, with feeders, is in use. The blocks of buildings to be lighted are somewhat scattered, and that the generating station itself is situated some distance away from the lighting. It is practically a small supply station, with, at present, a very bad load factor (fig. 1)—much worse than that of a town supply station.

Here, as also at Bradford, Sayers's automatic compensators are employed to counteract the fall of potential as the current increases.

The Midland Bradford Station, as is perhaps well known, is electrically lighted throughout, with the exception of a few gas lights under some low awnings at the distant ends of the platforms. Originally the incandescent lighting was provided for by compounded machines in duplicate. To change over from the working to the duplicate set involved careful handling on the part of the attendant. Discussing the matter with Mr. J. Sayers, my assistant, under whose supervision Bradford came, it was decided to insert a series machine in one main, and to dispense with the compounding. In the end this resulted in the employment of Sayers's "compensator," and which, I believe, was the first self-exciting machine made without winding on magnets. The application of this machine has been attended with the most perfect success. The transference of the load from the active to the duplicate set is now simply that from one shunt machine to another, while the compensation of the loss in pressure, consequent upon the increase in current, is most perfectly met.

At Bradford the wiring is on the simple parallel system. At Derby Dr. Hopkinson's three-wire system is in use. The success attending the employment of Sayers's compensators at Bradford naturally suggested their employment at Derby. At Bradford the extent of the compensation is limited to 11 volts, with a maximum current of 320 ampères. At Derby we have to serve a network, and the compensation is more involved, owing to the loss in the middle wire when either of the two sets of three separate groups of feeders is unevenly balanced. Dealing with one set the arrangement is as follows:—The outside wires of the grouped feeders are connected through a series machine driven by motor at a constant speed of 820 revolutions. This compensates for the loss in each outside wire.

The loss in the middle wire is, of course, double acting, raising the volts on the light load side, and depressing them on the other. To meet this Mr. Sayers takes the middle wire round the magnets of

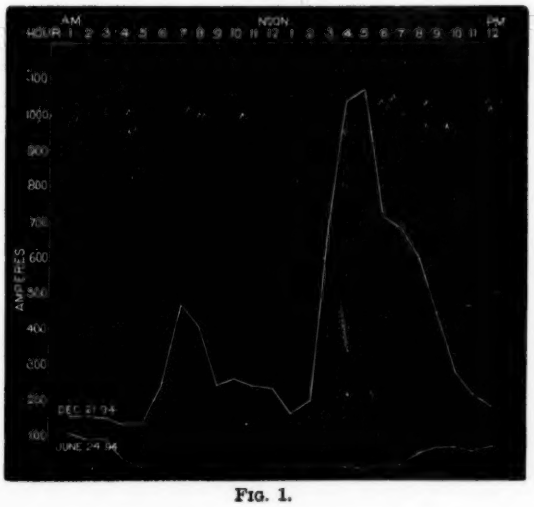


Fig. 1.

each of the two series dynamos, but in opposite directions one to the other. Any current passing in this wire therefore adds volts to one, and decreases the volts in the other, equally; and by suitably proportioning this winding it can be made to practically neutralise the loss in the third wire.

If both sides are fully loaded, and there is no loss, or no current passing in the middle wire, each series machine has to raise the voltage, on a current of 350 ampéres in each, some 7 volts; but, as

the third wire is one-half the section of the outer wires, it follows that, if one side should be fully loaded and the other not loaded at all, the compensators have to give 7 + 14 = 21 volts, and this they should do under the arrangement provided.

Such an extreme case never has arisen in practice; still, serious differences do occur—more so, perhaps, in such a supply as that under reference than in a town service—for the reason that, however equally you may plot out your scheme, it is quite impossible to foresee all those contingencies which, calling for extra attendance on the part of a special branch of the service, call for the load on that side accordingly.

A further advantage to be derived from the use of these compensators is to be found in the regular range of speed at which the engines require to be worked between light and full load. The volts of the main dynamos only require to be kept at the normal pressure —say, 110. There is no need for running the speed up so as to increase voltage to meet the drop consequent upon increase of current. It is one of those arrangements which simplify the working of a station at moments of pressure.

### Installation.

The establishment of the various installations, with the exception of that originally laid down by Messrs. Laing, Wharton & Down at St. Pancras, has been carried out by the company's own staff, under the immediate supervision of the author and his assistants, Mr. W. L. Preece and Mr. J. Sayers; and no small portion of the fittings required have been made in the company's electrical workshops.

Arc lighting wires not employed for the interior of buildings are laid underground. When drawn into iron piping, the wire is not armoured, but is protected by an extra outer serving of flax, hemp, &c. When armoured wire is used it is protected by ordinary drain tiles, split, or by planks of wood, employed more with the object of indicating to those who may have occasion to disturb the ground in its neighbourhood the fact that there is something beneath it, than with any idea of its power to absolutely resist injury. The insulation of the cable thus employed is specified at 5,000 megohms.

Arc lighting wires inside buildings are insulated with vulcanised India-rubber to not less than 300 megohms, and are, as a rule, supported on Johnson & Phillips's oil insulators. All suspended lamps are also insulated from the suspension fixing by oil insulators made for the purpose by the same firm.

For goods yard and siding working, the selection of the positions for the lamp pillars, and the height the lamp should stand from the ground, are matters of importance. The former is only to be dealt with in a satisfactory manner by learning from those who have the handling of the work, and by personal observation, where the light is most needed.

Each group of points requires special consideration. Shunters should be able to see when waggons have passed over each point, so that they may readily "knock off" the next waggon, or group of waggons, as the required points are clear of the trucks previously despatched over them.

At the mouth of the Leeds goods yard, where there are four roads, a light girder bridge has been thrown across, from which three lights are suspended between the roads, and the lighting is in consequence very good. The point is an important one, as from each line several fans of roads radiate, and it is beneath this bridge that the main part of the shunting is done. Without the girder bridge it would have been impossible to adequately light the intervening spaces between the roads.

It will be noticed that two classes of lamps are in use—that affording what is termed 1,200 C.P., and that known as 2,000 C.P.; the former requiring a current of 6·8 ampères, and the latter 10 ampères, the 10-ampère lamp will afford a larger body of light than will the 6·8-ampère lamp. In station buildings, where structural arrangements do not intervene, the 10-ampère lamp illumines a larger space than that produced by the lesser current, and is, as a rule, arranged at a higher elevation, and further apart in consequence. In goods yards and open spaces, theoretically, they should illuminate an equal extent of area. In point of fact, however, the illumination does not bear the same relation as when within enclosed spaces. Again, it may be said the 10-ampère lamp should be arranged at a higher elevation than the smaller lamp; but on the Midland it has been found convenient to employ only one class of pillar for outside work. The height adopted is 20 feet—*i.e.*, 20 feet between the arc and the level of the rails. The distance these pillars are apart varies for the 6·8-ampère lights from 90 to 100, and for the 10-ampère lights from 100 to 120 feet.

The distance between the lamps in the goods sheds must, in a great measure, be controlled by structural arrangements, cranes, &c. In open sheds, where these difficulties do not exist, a distance of 45 feet between 6·8-ampère lamps, and a distance of 60 feet between 10-ampère lamps, will be found convenient. Every case will, however, call for special consideration and treatment. To lay down a rule which shall be universal, and at the same time useful, is practically impossible.

The lights employed on the St. Pancras passenger station are 10-ampère. At the head of the station those lamps are 60 feet apart, the space between them increasing towards the end of the platforms where the passenger traffic is not so heavy, the distance between the two most distant lamps being 90 feet. The height of these lamps from the platform is 14 feet.

On the Leicester passenger station main platforms, where 10-ampère lights also are used, we are able to place the lights 90 feet apart, and at an elevation of 15 feet from the platform level. At Leicester the glass roof is lower than the St. Pancras roof, and the walls, being of glazed material, have a much greater reflecting power than is the case at St. Pancras, where the height of the lamps is 14 feet. The side platforms of the new Leicester station are covered by the usual glass awnings, and the lamps have to be arranged to meet the structure. Here they are 13 feet above the platform, and 75 feet apart. Fig. 2 represents the position of these lamps.

The lights employed in the Birmingham (Lawley Street) goods depôt and yard are 6·8 ampere. The Lawley Street depôt is still

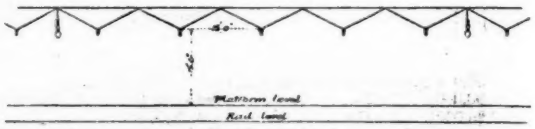


Fig. 2.—Leicester.—Longitudinal Section of Awning on the Side Platforms showing Position of Arc Lamps.

in an incomplete condition. A range of offices—now about to be constructed—will occupy the Lawley Street frontage, and the space between these offices and the main warehouse will be covered in by an awning.

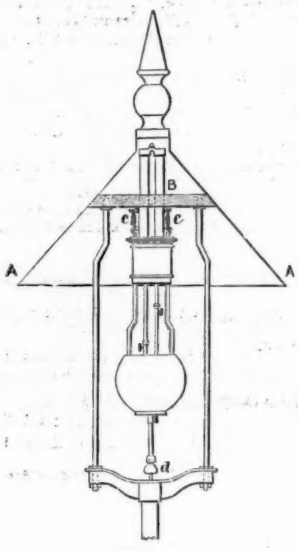


Fig. 3.

The lamps employed are double carbon, jointly affording 16 hours' lighting. 13 mm. carbons are used for the 10-ampère lamps, and 12 mm. for the 6·8-ampère lamps, for both top and bottom carbons.

In the earlier plants laid down the lamps are protected by sheet-

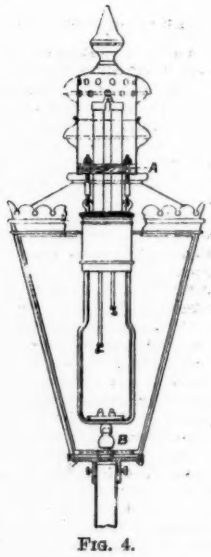


Fig. 4.

iron hoods, A (fig. 3). The lamp is suspended from a cross piece of timber, B, by insulated hooks, or hangers, C, and it is further supported at its base by an insulator, D.

Later constructions have been equipped with four-sided patterns (fig 4). The top portion of the lamp is insulated from the lantern.

TABLE II.—MIDLAND RAILWAY.—ELECTRIC LIGHTING.

*Details of Cost, Half-Years ending June 30th and December 31st, 1894, including Maintenance and Renewal.*

| Installation. | Half-year ending | Total units. | Total cost. | Cost. Per unit, including all charges. | Per arc lamp hour. | Per unit for incandescent lighting. | Per unit for labour. | Per unit for material. | Per unit for repairs. | Per unit for coal. |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | £ s. d. | d. | d. | d. | d. | d. | d. | d. |
| Somers Town ... ... | June 30 ... | 170,171 | 2,294 5 10 | 3·23 | 1·61* | ... | 1·15 | 0·65 | 0·29 | 1·00 |
| | Dec. 31 ... | 187,326 | 2,506 6 4 | 3·20 | 1·60* | ... | 1·09 | 1·03 | 0·27 | 0·82 |
| Bradford ... ... ... | June 30 ... | 82,984 | 1,115 15 0 | 3·23 | 1·39 | 2·7 | 1·19 | 0·56 | 0·47 | 0·80 |
| | Dec. 31 ... | 100,388 | 967 5 6 | 2·36 | 0·98 | 2·0 | 1·06 | 0·56 | 0·18 | 0·44 |
| Birmingham (Central) ... | June 30 ... | 70,774 | 950 10 11 | 3·22 | 1·60* | 3·3 | 1·43 | 0·68 | 0·35 | 0·48 |
| | Dec. 31 ... | 90,847 | 945 4 6 | 2·49 | 1·22* | 2·7 | 1·03 | 0·64 | 0·34 | 0·37 |
| „ (Lawley St.) | June 30 ... | 69,960 | 1,113 9 5 | 2·97 | 1·00 | ... | 1·33 | 0·80 | 0·20 | 0·60 |
| | Dec. 31 ... | 102,481 | 1,103 14 2 | 2·58 | 0·85 | ... | 1·25 | 0·62 | 0·24 | 0·44 |
| Hunslet ... ... ... | June 30 ... | 70,985 | 1,157 4 7 | 3·90 | 1·41 | 3·6 | 1·80 | 0·91 | 0·27 | 0·79 |
| | Dec. 31 ... | 75,864 | 1,237 6 1 | 3·90 | 1·47 | 4·0 | 1·89 | 0·85 | 0·55 | 0·65 |
| Derby ... ... ... | June 30 ... | 60,389 | 873 8 9 | 3·40 | ... | 3·4 | 1·70 | 0·76 | 0·19 | 0·65 |
| | Dec. 31 ... | 77,740 | 1,082 14 9 | 3·34 | ... | 3·3 | 1·45 | 0·94 | 0·40 | 0·53 |

* These are 10-ampère lamps, 2,000 C.P. All others are 6·8-ampère, 1,200 C.P.

at A by a block of dry wood and insulated hooks, and the base as in fig. 3, is supported on an insulator, B.

These lanterns have been glazed:—

(*a*) With plain clear glass,
(*b*) With what is termed "blurred" glass,
(*c*) With fluted glass,

samples of which are on the the table.

The clear glass can be used only to a limited extent. The naked arc is objectionable to men working within its immediate range. Clear glass is, perhaps, still more objectionable, from the strong shadows which attend its use. "Blurred" glass has been employed with the object of toning down the glare of the arc and breaking up the shadows. It is, however, not in this respect so successful as the fluted glass. With the flutings horizontally arranged the shadows are completely broken up, and the refraction is so good that the light immediately underneath the pillar is practically as good as that 10 feet distant.

The lanterns are made so that the chimney may lift off at A. All lamp pillars are provided at their base with switches which entirely sever the connection of the lamp wires with the line wires; and in all modern constructions the switch, when in the "off" position, also places the lamp to earth. The lamp pillar complete is shown in fig. 5. The switch is enclosed in the base of the pillar.

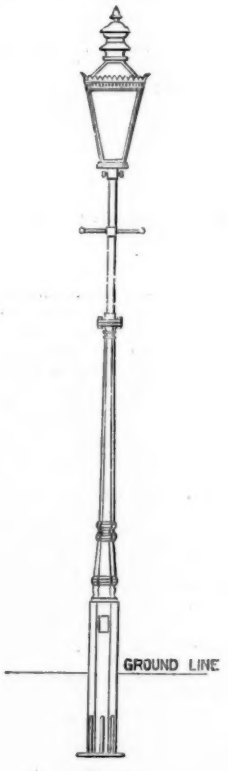


FIG. 5.

Where lamps are worked in series it will, in determining the circuit arrangements, be found desirable to ascertain the period during which the lights are required for use, and to group them accordingly, so that they may be turned off and on in sections, if possible, from the switchboard in the dynamo or transformer room. The groups should also be so arranged that, combined, they may equal the capacity of a machine. The circuits applicable to indoor lighting should be so arranged as to admit of their being worked independent of the outdoor or yard circuits, the light being required indoors at an earlier hour than those out of doors.

For incandescent work the wires are, as a rule, run in grooved casing of the orthodox kind. The casing and cover are fixed by the outer and not by the centre fillet; the object in rejecting the centre screw being to exclude the aid it would afford to any *creeping* of the current across the centre fillet, should leakage at any time arise. Under such a condition it is clear the screw in the centre fillet would largely reduce the resistance between the two wires—that it would, in fact, become a sort of "half-way house" towards the passage of the current, and tend to ignite the wood. The wooden casing as at present employed affords a convenient mode of dealing with the wiring of rooms; but, in view of the description of casing which one not unfrequently sees employed, and, indeed, under any circumstances, it can hardly be regarded as a perfectly satisfactory mode. If an artistic rectangular casing or tubing of metal which would not readily melt could be produced at a reasonable price, it would no doubt prove exceedingly serviceable.

Apart from the points referred to, there is, in the application of the electric light to railway working, little of a sufficiently special character to call for further reference. Numbers of the fittings employed, switches, switchboards, controlling arrangements, &c.—most of which are made in the company's own shops—are to be found in connection with each installation; but in this the installations on the Midland do not differ from all other installations, inasmuch as most have one or more specialities peculiar to themselves. Any such specialities are best investigated on the spot, and the Midland Railway Company will at all times be pleased to afford facilities for an inspection of any one of their works.

The question which will probably most interest railway companies is that of

## COST.

To lay down an electric lighting plant is probably more costly than to establish means for illumination by gas; but when we take into consideration the relative cost of working, the light derived from each source—light for light, or candle-power for candle-power—the advantage is so largely in favour of the electric light as to more than fully compensate for any larger first outlay which may be incurred.

The tabulated statement (II.) will afford data with respect to the output and cost of working of several of the electric lighting stations on the Midland. Certain charges for labour, engine and boiler repairs, and for coal, owing to charges for these items being combined with similar charges for hydraulic machinery located in the same building, it is possible, are not so strictly allocated as is desirable for a paper of this kind; still they are not largely inaccurate. They should, however, be regarded as maximum charges.

Nor are the charges in any case comparable with those of city supply stations. The arc lighting load, varying throughout the night according to traffic demands, is not so constant as that of a town service, while that for incandescent lighting lacks the continued evening service associated with town lighting. At goods stations and for office lighting the latter rises to its maximum in the depth of winter for a period not exceeding an hour and a half daily, viz., 4 to 5.30 p.m., while in summer the demand is still less. Still, the result, as compared with the cost of current obtained from a public supply source, is greatly in favour of an independent generating plant.

In criticising Table II., viz., that of cost, we must also bear in mind the fact that the cost per unit carries with it the cost of carbons and carboning the arc lamps, together with cleaning, repairing, &c., and that the cost for incandescent lighting also, as a rule, covers the renewal of lamps. The only exception rests with Bradford, where the lamps in the hotel are replaced by the hotel department, and their cost is not therefore included in the cost shown in the tabulated statement.

*(To be continued.)*

# THE BEST COMBINATION OF PLANT, MAINS, &c., FOR AN ELECTRIC LIGHT UNDERTAKING.*

By R. A. DAWBARN, M.I.E.E.

(*Concluded from page* 435.)

I would now go much further, and recommend that each alternator should have its own exciter, large enough for its own requirements only, and kept entirely independent of any other exciter. The objection usually made to separately exciting each alternator is that it renders it very difficult to regulate all the exciter fields together, to compensate for loss in mains at various loads, and at the same time retain the proper distribution of load between the various alternators running in parallel, *i.e.*, each doing its proper share of the load; but by the arrangement I now suggest, this difficulty would be entirely overcome, viz., by running all alternators *at constant pressure*, and making no adjustment of exciter fields whatever (except for temperature correction of alternator field coils), and by doing all pressure regulation by an impedance coil or augmentator in each feeder circuit leaving the station. There should in any case be some provision for varying the pressure on the several feeders separately, and the method suggested would at once accomplish this desideratum, and dispense with all other forms of regulation. It would, moreover, simplify the switchboards, reduce their cost, save the cost of a duplicate steam exciter and its accessories, and save the possibility of throwing out of use more than one generating set by the failure of an exciter.

*Switchboards.*—The Raworth system of switch pillars is far in advance of anything that has been done by others, but they are not suitable, nor indeed intended, for comparatively small stations.

In addition to the usual Brush practice, viz.:—

(*a*) That each alternator should have its own panel.

(*b*) That each feeder should have its own panel, and

(*c*) That there should be one synchroniser panel common to all.

I submit the following:—

(*d*) That each panel should be a slab of marble or slate without wood frame.

(*e*) That the panels should be placed close together, or leaving only a 3 or 4-inch air space between, so as to be within easy reach of one attendant.

(*f*) That each panel should be supported on large insulators attached to an angle iron frame, supported by two or more cast-iron standards off the floor.

(*g*) That the frame should be placed on a platform about 2 feet only above engine room floor, with at least 3 feet between back of boards and wall, and preferably 4 feet between front of boards and handrail, which latter should be of wood, supported on iron pillars, so placed that they are not likely to be handled.

Each alternator panel would have a pair of high tension switches and fuses, Raworth's return current fuse, high tension ammeter and voltmeter, synchroniser sockets, and an exciter field regulator, which latter would be fitted with stops carefully adjusted once for all when starting the station, so that the attendant has merely to start a fresh alternator with the regulator slide hard up against one stop (all resistance in) and gradually move it by easy stages until the other stop is reached, when the field coil has attained practically its final temperature.

Each feeder panel would be fitted with a pair of high tension switches and fuses, an ammeter, augmentator to adjust the pressure according to load, and a registering meter.

It will be noted that this arrangement is exceptionally simple, and yet meets all the requirements fully.

A slow break alternator field switch for emergency, and a fuse, might be fitted on each alternator bed, but would not form part of the switchboards proper.

If there are not less than, say, four main feeders leaving the station, it would make the arrangements more complete to fit each feeder panel with a rock-over switch and system of plug holes to admit of throwing any feeder on to the omnibus bars (for parallel working) or on to any alternator independently at will.

All high tension fuses on the switchboard should be of the Bates type, and on every board a pair of spare fuse handles should be placed ready wired and available for the immediate replacement of any that may fuse.

Of the arrangement of isolating valves of steam pipes on the ring main system, of steam separators and traps, and such like accessories, I have no need to speak.

Before leaving the generating station, however, I should like to add that whilst the weekly publication of the Board of Trade returns in *Lightning* has undoubtedly stimulated generating station engineers, and led to highly satisfactory reductions of working costs, I feel that we have not even yet sufficiently grasped the absolute necessity of *continuity of supply* above all other considerations, and I contend that the attainment of this object is not to be looked for in the direction of multiplication of parts, however admirable their object or design; but, on the contrary, by rigid simplicity such as I have attempted to sketch. Every item that is not essential to good service should be regarded as a possible source of weakness, and discarded forthwith, unless it is of such a nature that its breakdown would cause no interruption of supply whatever—as, for instance, a fuel economiser, an automatic stoker, a signalling appliance, &c.—then, and then only, is it admissible to introduce it on its economic merits.

In furtherance of this all-important object of uninterrupted supply, I submit the following additional suggestions:—

(*a*) That workmen's dwellings should form part of the station buildings, or be adjacent thereto, and all telegraphically connected to station where the minimum staff would be required in the engine room, but others would be within easy call in an emergency, either from their own quarters or from the general reading and smoke rooms, which latter should be well equipped with technical as well as lighter literature.

(*b*) That all main bearings should be water-jacketed, and a hose pipe kept ready connected opposite each generating set.

(*c*) That the main bearings and cross-head slides of, at any rate, the day load set, should be fitted with temperature alarms, preferably on the aneroid principle.

(*d*) That the station lighting should be in no case trusted to one circuit, and should include at least one large, but portable, oil lamp kept near the switchboards.

(*e*) That the station should be connected by telephone with one or more sub-stations, the engineer's residence, fire station, and even police station.

(*f*) That arrangements should be made with the police for the man on night duty to look into the station periodically between, say, midnight and dawn, during which time one man only might be left in the station, with these precautions, in addition to a low water boiler alarm. The night station man would have strict instructions not to touch switchboards under any circumstance, but, in an emergency, to ring the night alarm, which would bring help from the workmen's quarters.

### Mains and Accessories Outside the Station.

Questions relating to mains, such as their type, section and disposition, are no less important than the generating station, and afford even greater scope for waste of capital than the generating plant. I must, however, for want of time, deal with the chief points as briefly as possible.

*Primaries.*—I strongly advocate a "drawing in" system for the high pressure cables, using concentric cables insulated with vulcanised rubber, or specially prepared paper sheathed in lead. The cable to be drawn into a cast-iron or stoneware pipe. The estimates, A and B, below, give the relative costs of these arrangements, and so far as one is at present able to judge, in the absence of a sufficiently severe time test, in regard to paper cables, I feel that the latter will show the best all round results, taking both capital outlay and upkeep duly into consideration.

| *A.* | £ | s. | d. |
|---|---|---|---|
| 100 yards 2½ cubic inch socket pipe laid, say ... | 11 | 5 | 0 |
| 100 yards No. 100 (·1 square inch) concentric high tension cable, *rubber* insulation, drawn in | 35 | 0 | 0 |
| Two high tension draw boxes ... ... ... | 6 | 0 | 0 |
| | £52 | 5 | 0 |

| *B.* | £ | s. | d. |
|---|---|---|---|
| 100 yards 3-inch stoneware pipe, with patent joint, laid ... ... ... ... ... ... | 5 | 10 | 0 |
| 100 yards No. 100 concentric high tension cable, *paper* insulation, lead covered, drawn in ... | 25 | 0 | 0 |
| Two high tension draw boxes ... ... ... | 6 | 0 | 0 |
| | £36 | 10 | 0 |

| | | | |
|---|---|---|---|
| Trenching and repaving, common to both, at per 100 yards, say, on average ... ... ... | £12 | 10 | 0 |

By adopting a drawing system, any cable can be withdrawn and replaced by a larger one, when desired, whilst the one withdrawn can be used again elsewhere, for there are no joints upon the primaries between transformer centres, and the cable, consequently, will come out intact. In a large number of towns steel-armoured primaries are now being laid directly in the ground. This is the result of competition, as it is the lowest first cost system—not to say "cheapest;" for when any trouble *does* occur, or extensions are required, even if 10 years or more after first put down, I feel confident that the advantage, even as regards capital spent, will change over to the drawing system.

Cast-iron or stoneware socket pipes, 2 to 2½ inches diameter, should be employed, and a separate concentric cable in each pipe. Wrought-iron pipes are to be avoided, as they can only withstand for a few years the attack of the chemicals to be found under our streets, and are in any case much more costly than cast-iron pipes.

I have placed on the table before you a sample of a stoneware pipe with a patent joint. To my mind this is the best form of conduit yet introduced for *high-tension feeders*, but requires a lead-covered cable to be drawn in, as the Board of Trade require a continuous external metal sheathing.

As regards fear of fracture due to traffic above, I consider this very remote if they are laid fairly deep, say, 3 feet, in view of the small diameters employed. Moreover, their short length (2 feet) and form of joint render them exceptionally flexible, and able to withstand subsidence better than the cast-iron pipe. The cost of laying such a system is obviously trifling, and in addition to economy, it has the advantage of requiring the trench left open a very short time. The depreciation of stoneware is nil. I ought to explain that the sample is much shorter than the standard pipes as used.

In some cases ring feeders are adopted that can be fed either way round, and any section cut out, without interrupting the supply, as

* A paper read before the Falcon Works Engineering Society, Loughborough, February 6th, 1895.

in the ring steam pipe system, but I venture to suggest that the better method is to employ separate feeders to serve three or four transformer points at most, and the secondaries of these transformers disconnected from those served by another feeder, thus ensuring that no defect in a secondary cable, service connection, transformer or feeder, can possibly cause an interruption to more than one limited section of the lighting.

Returning to the figures before you, I should like just to point out:—

(*a*) That even when employing only two draw boxes per 100 yards, these cost as much as the conduit laid complete.

(*b*) That to re-trench costs half as much as a new cable large enough for 200 *kw.*, or, in other words, about as much as a new 100 *kw. cable.*

*Secondary Low-tension Service Cables.*—As regards low-tension distributing cables, the frequency of house service joints renders a drawing system inoperative, except in the matter of drawing *in*. It is consequently most economical to adopt steel-armoured concentric cables laid directly in the ground without further protection. For low tension work a rubber cable is out of the question, on the score of first cost, and experience shows that the cheaper cables insulated with fibrous materials treated in various ways satisfactorily fulfil the conditions of actual practice. Cables of this class require a continuous lead sheathing, in consequence of the hygroscopic nature of the insulating material; but notwithstanding this they are much cheaper than rubber insulated cables without lead, and provided only the lead is pure, should last for ages. The steel armouring is to protect against mechanical injury from picks, &c.

I have already referred to the extraordinary elasticity of the alternate current transformer system. We can, for instance, use as small a low tension distributing cable (from which the house services are taken) as we think fit; but if we put in a very small one, the transformers which feed it will, in consequence, be small and numerous. After carefully considering this matter, I have fixed upon a section of copper of ·100 square inch as the minimum for all ordinary conditions. Now, if we load this cable to 1,000 ampères per square inch, it will carry 100 ampères, and a transformer feeding it in two directions would require to give as a maximum 200 ampères at, say, 100 volts, or 20 kw. Let us take an 18-kw. transformer as our standard, for it is large enough to be very efficient on light load. Some transformers of this size recently designed by Mr. Mordey, and made by the Brush Company for Bolton, took on no load, only ·833 per cent. of full load, and if continuously in circuit with a 10 per cent. load factor, would show an all-the-year-round efficiency of about 90 per cent. Thus, if no smaller transformers than these are employed, and all properly loaded, there is no scope for automatic devices for cutting transformers in or out of circuit, keeping in mind the immense importance of simplicity.

We now come to the question: How far apart should the transformers be placed? Of course this must depend to some extent upon the demand. If this be taken in a given case as one 60-watt lamp per yard of frontage, an 18 kw. transformer will serve 300 yards, or 150 yards on each side of it, and assuming the load to be evenly distributed along the frontage, the difference in pressure at full load of 90 ampères between the transformer point and the extremity of the ·100 cable 150 yards distant, would be less than 3·4 volts; and if we arrange for the pressure at the transformer terminals during full load to be 1·7 volt up, the volts at the distant end would be 1·7 down, leaving a margin of ·3 volt for defective regulation at the station, or uneven distribution, and still complying with Board of Trade requirements, viz, a variation of pressure not exceeding 2 per cent. up or down.

Now, it does not matter how much the load hereafter increases, it will never become necessary to increase or augment these low-tension cables: for, suppose a 300 yards' length between two 18 kw. transformers becomes overloaded, it is only necessary to insert a third transformer half-way between the two (assuming even distribution), and the load on the cable is at once halved.

If it is estimated that the demand will quickly exceed one 60-watt lamp per yard of frontage, it is advisable to employ a larger cable, and correspondingly larger transformers, otherwise the transformers would require to be too close together in the early stages, thereby losing the advantage of the slightly higher efficiency of the larger transformers, and when further demand occurs, and additional transformers are required, it will be found that too much has been spent on transformers and their chambers and too little on cable.

On the other hand, let us see if, with the old basis of one 60-watt lamp per yard of frontage, it is advisable to employ a larger cable and transformers further apart, which of course also implies transformers of larger size.

To take a simple case: Suppose we adopt No. 200 cable (·2 square inch) in place of No. 100 (*i.e.*, double the size). The transformers will now be—the square root of double the original distance apart, or 1·414 times 300 yards = 424·2 yards, say, 425 yards apart, and the transformers will accordingly be 25·46 kw. size. The transformer chambers may be taken as costing £20 and £24 respectively for each 18 and 25 kw. transformer. We thus have:—

*Scheme A.*

No. 100 cable and 18 kw. transformer 300 yards apart, costing:—

| | | | |
|---|---|---|---|
| For cable per 100 yards, say ... ... ... | £20 | 12 | 0 |
| Transformer $\frac{56}{3}$ per 100 yards, say ... ... | 18 | 13 | 6 |
| Transformer chamber $\frac{20}{3}$ per 100 yards ... | 6 | 13 | 6 |
| | £45 | 19 | 0 |

*Scheme B.*

No. 200 cable and 25·46 kw. transformer 425 yards apart, costing:—

| | | | |
|---|---|---|---|
| For cable per 100 yards ... ... ... ... | £34 | 12 | 0 |
| Transformer $\frac{68}{4{\cdot}25}$ per 100 yards ... ... | 16 | 0 | 0 |
| Transformer chamber $\frac{24}{4{\cdot}25}$ per 100 yards, say... | 6 | 13 | 0 |
| | £57 | 5 | 0 |

Showing a difference of £11 6s. per 100 yards in favour of the No. 100 cable (or Scheme A).

A great deal of judgment must be exercised in deciding where to stop low tension cable. They should not, of course, be laid where there is but a remote prospect of service connections being demanded, as they can be started again further on in the same street where the prospects are better. Good judgment in this matter may save hundreds of pounds of capital without sacrificing any practical advantage, however small.

*Housing Transformers.*—It will be seen from the figures just given that the housing of transformers is an important item. For the sake of simplicity, we have so far considered only the one side of a street and the housing of but one transformer, but it is usual in the busy streets to run a service cable on each side, and to employ one underground chamber to hold the transformers for both sides. Where practicable, they should be arranged at main thoroughfare crossings, and thus accommodate three or four transformers in one chamber, feeding four service cables. A chamber to hold two or three 18 kw. transformers costs about £35.

It is now fully three years since I first recommended the use of ornamental cast-iron street pillars for transformers, similar to post office pillar boxes, but smaller. The largest post office pillar costs about £8, so it is fair to say we could house a 9 to 15-kw. transformer on this system for £10. Where the pavements are broad, or in the residential districts where the traffic is light, there can be no serious objection to these, and by their adoption, all questions of ventilation and drainage are at once disposed of. Such pillars would be of the greatest value in the residential districts where the lamp density per yard run is always very poor. The low tension cable may then be only about No. 50, fed at 300-yard intervals by 9 kw. transformers, which can be made to take only about 1·1 per cent. of full load on open secondaries.

It is still better to arrange the transformers in the bases of arc lamp-posts, and this system has been adopted by Messrs. Bramwell and Harris at Derby; but instead of supplying the arc from the same transformer, they have employed direct current arcs and separate plant. Unfortunately street arc lighting is never wanted where the pillar system is of most use, viz., in the residential districts; but I would combine transformer pillars with ordinary gas lamp-posts (taking care to lead the gas pipe outside), rather than resort either to underground chambers, where comparatively small transformers are required, or to the still greater evil of a transformer to each consumer.

In isolated cases, where separate transformers are inevitable, these should be served only from "sub," as opposed to "trunk" mains, or more correctly, "high tension distributors," controlled by a switch and fuse box, where it joins the main feeder. Such junctions, where possible, to be made at the nearest transformer chamber.

*Public Buildings.*—There is one condition under which separate transformers can be employed with great advantage. I refer to the lighting of theatres, churches and public halls of all kinds, and particularly those most intermittently used. By employing a separate local transformer to supply about three-fourths of the lights, and connecting the remaining quarter to the ordinary low tension supply mains, you not only get the most economical conditions as regards transformer losses, but in addition, double security against total extinction, which, as we know too well from gas history, may lead to panic, with appalling results. The primary of the local transformer in such cases should, if possible, be connected through a submain to a different feeder to that which supplies the low tension service main to which the remaining lamps are connected. I, of course, mean the local transformers to be turned on only for the meetings, and to feed entirely distinct circuits from those fed off the ordinary low tension service mains. The simplest way of ensuring the local transformers being turned off directly the meeting is over, would be to insert the meter in the primary, or to employ a simple hour meter on its secondary, by special arrangement with the consumer, giving him the equivalent of a 10 or 15 per cent. discount as a bait.

It has occurred to me that in special cases where it is not feasible to modernise the whole system, it would be well worth while making arrangements both with shopkeepers and occupiers of private houses to induce them to switch off their primaries, the former on leaving their premises for the night, and the latter on going to bed, by employing in addition to the ordinary meter a simple hour meter in the primary circuit, and giving a rebate according to the size of the transformer, proportional to the hours the transformer is shown to have been disconnected each quarter.

For hotels and large establishments, two transformers should certainly be employed, and used like the two sources of supply I have suggested for public halls.

*Breakdown Transformer.*—Carrying out the suggestion that electric light stations should be worked more on the lines of fire stations, I would have every station provided with a light four-wheel carriage equipped with one large transformer and two reels of flexible cable, one high tension and one low tension, so that immediately a defect in a transformer is reported, it could be run out by hand and tem-

porarily connected, often, no doubt, before the remaining transformers of the group become too hot from the excess load. The carriage would of course have electric danger lights when in use at night, and suitable accommodation for a watchman.

Let me conclude by briefly pointing out the directions in which I think we must look for developments tending to materially reduce the cost of electric light in the immediate future. These are:—

(*a*) To higher efficiency cheap lamps.

(*b*) To satisfactory high voltage lamps, say, 200 volts, minimising the cost of low tension cables.

(*c*) To the further reduction of low tension cables by adopting concentric cables with uninsulated returns—a sample of such a cable has very kindly been lent me by Mr. J. D. F. Andrews, of Westminster, for the purposes of this meeting, and is now before you.

(*d*) To the greatly reduced cost of each house service connection, by adopting the Andrews system, or something similar, costing at the most 5s., against 30s. for an ordinary double insulated concentric joint box laid (omitting the actual house cable in each case).

(*e*) To the adoption of concentric internal house wiring with uninsulated outer with single-pole switches, fuses, &c., and the abolition of wood casings for all plain work where cost is a consideration.

(*f*) To a somewhat improved load factor, resulting from an extended use of motors, cooking and heating apparatus, &c.

(*g*) To substantially lower annual costs of repairs of every item of plant and apparatus employed as the result of experience, and the survival of the fittest.

## THE TELEPHONE SERVICE: PARLIAMENTARY INQUIRY.

The Select Committee sitting to inquire into the telephone system of the country, sat again on Friday last, Mr. Arnold Morley presiding.

Mr. H. E. Clare, deputy town clerk of Liverpool, said he was a member of the Municipal Corporations' Association, and a member of the committee of that body on telephones, and he would give evidence on behalf of that body. He considered the telephone was a commercial necessity, and, looking at it as a trade necessity, it seemed to the Corporations most important to have communication between the large centres of commerce, and that it should be made as easy and cheap as possible. They thought that it was of far more importance to develop communication between commercial centres than in any given exchange area. He believed that the greatest part of the Stock Exchange business between Liverpool and London was done by telephone. The Corporations considered that the whole thing must be considered as a national undertaking, and not one to be treated as a local matter.

The Chairman: You think that the Goverment has done right in taking over the trunk-wire system of the National Telephone Company?—Our view, in looking at the case as far as we can do, is that the Government ought to take over the whole of the telephone system, because the law has declared the telephone system part of the Postmaster-General's monopoly under the Telegraph Act; and, therefore, it seems to us his duty to take over the whole thing. It seems to us the natural course is for the Government to take over the whole system. But, of course, if the Postmaster-General has come to the conclusion that, in the interests of the country, it is not advisable, we must accept that decision as being founded on much better grounds than we have had the opportunity of considering. I may say we anticipate that if the Government would take over the whole system eventually some considerable reduction in the charges might be brought about, and it might be worked at something like cost price, and the development of the system would probably take place in cases where it may not pay at once, but in the interests of the public, and to meet a public demand, the Postmaster-General would spend the money, although he could not have a profit directly arising from it.

You anticipate advantages from the Government taking over the trunk-wire system, which you think a most important part of the telephone system?—As far as I can see, the immediate effect will be to cause some delay in getting into communication, but of course that delay can be rectified by increasing the number of trunk wires, and if the Government is prepared to increase the lines to a greater extent than the National Telephone Company, then undoubtedly it will be a benefit to the public. But I cannot see from the agreement they are going to decrease the charges.

But you are aware that Government have undertaken an extension of the trunk-wire system?—Yes; and if they carry out that system, then it will be a benefit to the country.

Witness, continuing, said that, looking at the telephone system as a national one, if the Government did not take over the whole system, and only took over the trunk lines, then it appeared to them there was only one course to be followed, and that was to place the whole of the local exchanges into the hands of one body and under one control. The inconvenience which would arise by allowing any particular area to isolate itself from the rest of the country would be very great in all commercial matters. Suppose Liverpool isolated itself from the system which pertained in other areas, they would not be able to communicate with any other town without an extra payment in addition to that made by the Government for the trunk lines, because they would have to pay an extra fee to the body, whoever it might be, who had the exchange in the town they wished to communicate with. On the other hand, anyone in another part of the country wishing to communicate with Liverpool, would have to pay a charge to the body in Liverpool for the use of their instruments. It would, he considered, be a positive evil if any local area was allowed to separate itself from the rest of the country, and in order to avoid that, he was strongly of opinion that the whole system in local areas should be under one body—if not the State, then some company.

The Chairman: You express a strong opinion against the municipalisation of telephones?—I am only expressing the opinion of the whole of the association. We think the municipalisation of local areas is impracticable, and wrong in principle.

We have heard evidence from witnesses representing towns in Scotland who have expressed the absence of any objection to competition within the same area?—I cannot see how competition in the telephone can do any good. It seems to me it must result only in increased expense. In any town where there is any custom, we have got the National Telephone Company, who have made the exchange and are in possession. Suppose another company were to get a license to compete. What chance would there be of the competition of this new company being of any practical use when they are dealing with a company with £7,000,000 of capital, who can put their subscribers into communication with any other town in the country, whereas the new company could not do so without an increased charge. It must result in the competing company being bought up by the National Company, and in that way the National Company has its capital unduly inflated by the purchase, and so every purchase must necessarily increase their capital on which dividends have to be paid.

Would you make the same statement with regard to a municipal body?—Yes; I think in case the municipality attempted to compete the same circumstances would prevail, viz., that you would have a corporation competing with a company who would "go one better" than the corporation in any charges they might make. The corporation would have to pledge the rates to carry on an undertaking, which in my opinion ought never to be charged to the rates. With competition it is perfectly obvious to me that they would not pay their working charges, and would have to pay out of the rates, and the ratepayers would not stand that long. Again, I do not think that Parliament would like to pledge the rates in a trade matter of this character. The telephone is not like water or gas; it is more for the use of the capitalist, and not the general body of ratepayers.

Is that the view of the association as a whole?—I think so. There has been no definite resolution on the subject, but I have been at all the meetings when this telephone question has been discussed, and have strongly spoken on this point. I have not been contradicted, nor have I heard any objection, and I think I am speaking the general opinion of the Municipal Corporations Association that the municipalisation of telephones would be a wrong thing.

And they represent most of the corporations?—Yes, most of the corporations of England. The City of London has not come into the association; we do not consider vestries corporations, and the London County Council, is an outside body. The Scotch boroughs were not members of the association.

Should the committee assume that you are satisfied with the present system?—I may say, as far as Liverpool is concerned, I believe the telephones are managed as well as they can be under the circumstances. We have a very large area, and the communication is very good indeed; of course, subject to its being interrupted by occasional storms and unforeseen accidents, which must happen in the case of an undertaking of this character. Speaking generally, I think there are very few complaints to be made against the way in which the exchange is carried out. What we think is, that we shall never get the telephone as cheaply as we should be supplied, or as efficiently, so long as the company have to work under a license which ends in 16 years, and an agreement which does not authorise them to maintain their organisation. The company must be hampered by the excessive charges for wayleave, and the system of blackmailing which undoubtedly goes on in the case of some owners, where the company has wayleave. As this is a national undertaking, I think Parliament would be justified in endowing the company with such powers as would enable them to maintain their property in a proper way, and to use the streets; but such power must be accompanied by very strict restrictions. It is difficult for me to say what restrictions should be made, for, as a corporation, we know little of the circumstances of the company.

Replying to the Chairman as to what restrictions he would suggest, Witness said that, in the first place, they would have to decide on what powers were necessary, and, possibly, the powers that the Postmaster-General had under the Telegraph Act might, subject to some modifications, be all that were necessary. With regard to the powers to utilise the streets, he thought if the Corporation desired the company to lay their lines under the streets, then the work should be done by the Corporation at the expense of the company; but if the Corporation thought it undesirable that the streets should be broken up, and preferred to have the wires overhead, he did not think the company should be allowed to force them to lay them under the streets. He would leave it to the Corporation to decide whether it should be an overhead or underground system. The Manchester Corporation entered into an agreement with the National Company, by which they constructed the works, and charged the company for it. He did not think at present the Corporation had power to do that for the company. The next point would be the restrictions. First there should be a fair maximum dividend to be allowed the company, having regard to the amount of capital represented by their works. Then, in conjunction with a maximum dividend, there should be a fixed maximum charge, which the company should be allowed to make in different classes of local exchange areas, and there should be a provision preventing them unfairly favouring one exchange area at the expense of others. There should be no undue preference as between one exchange and another, and there should be no undue preference as between one subscriber and another, where the circumstances were the same. He only said that was a point to be inquired into. Then the company should be required to give such a number of call offices as Parliament should think should be given. That

would be a great benefit where people could not afford to pay £10 for the system, and would greatly extend it.

The Chairman: How would you justify the imposition of these things on a company which is only licensed for 16 years.

Witness said he recognised that they could not impose those restrictions unless they gave something in return. The first thing would be to extend the company's powers to maintain their undertaking. Secondly, he thought the term of 16 years should be abolished, and the company should be put in the same position as gas and water companies, subject to conditions preventing a monopoly being created. In order to prevent that, he would suggest that there might be given to the Government the power to acquire the company's whole undertaking at some reasonable notice—say 12 months, on some stated terms to be set out in the Act of Parliament itself, so that the company and the shareholders would know exactly what was hanging over their heads. He was aware that the Committee of 1892 reported strongly against the extension of the license, but the corporations did not appear before that Committee, and he could only point out that it stood to common sense that if a company was working under conditions which practically brought them to an end at the end of 16 years, they could not develop their system or supply it so cheaply as if they had a permanent existence. It was obvious that they must put out of revenue a larger reserve fund to provide against what would happen when their license terminated, and that had to come out of the subscribers' pockets. The extra amount they had to pay for wayleave and blackmail also came out of the subscribers' pockets, and the dividend of 5 per cent. came from the same place. If their dividend was reduced to 4 per cent. with a more permanent security behind it, it would be as much in the market as the 5 per cent. of to-day, and that would mean a great deal towards reducing the charge for the system. What the corporations wanted was for the Postmaster-General or some company to be put in a position for them to supply the system in the best possible way, and at the least possible cost, and they did not want them placed under unworkable conditions for the benefit of those to come 15 or 16 years after.

Mr. Snape asked if the witness represented solely the views of the Municipal Corporations Association.

Witness said he acted on the following resolution passed by the special committee of that body on March 20th of that year, viz.:—"That the principles involved in the resolution of the council of the 22nd of November, 1894, should be adhered to, namely:—'That in the opinion of the council no powers should be given to any telephone company which will enable them to interfere with streets, or with the rights of individuals in property, unless statutory conditions and obligations are at the same time imposed on the company for the protection of the public, particularly with regard to maximum charges, maximum dividends, and obligations to supply; that the subject should be treated as an imperial, and not as a local, one; and, therefore, it should be urged on Parliament that so much of the draft agreement between the Postmaster-General and the telephone companies as relates to vesting in the companies the wayleave powers of the Postmaster-General under the Telegraph Acts should not be carried out.' That as the Postmaster-General has refused to strike out of the Agreement the provisions objected to by this association, the corporations be recommended to refuse to give their consents under the Telegraph Act, 1892, to the exercise by the National Telephone Company of the powers of the Postmaster-General under the Telegraph Acts. That the town clerk of Leeds and the deputy town clerk of Liverpool be asked to represent the views of this committee, as expressed in the foregoing resolution, before the select committee."

Mr. Snape: If Parliament refuses to give powers to the company, would you allow the municipalities to have them then?—If they will not give them to the company, they will not I suppose give them to anyone.

Replying to Mr. Fletcher Moulton, Witness said there was no doubt that users of the telephone in a local area were greater than those between town and town, but the latter were much cramped by reason of the want of trunk wires. He had been told that between Liverpool and Manchester the telegraph had been practically ousted by the telephone. He thought it was a great mistake for the Postmaster-General ever to have farmed any part of his monopoly, but the natural solution of the difficulty seemed to him to get it back again. He had been told by friends in Manchester that the result of having two companies there was that they were forced to subscribe to the two systems. He thought if the price was brought down to £5 a number of small tradesmen would go in for it.

Mr. Moulton: Suppose the municipalities take up the telephone, would they not be the most effective competitors of the National Telephone Company?—I do not know. If a corporation takes up any work it has to pay a dividend whether it earns it or not or fall back on the rates.

It would not pay so much as the Telephone Company?—I think the company pay 5 per cent. The Corporation would have to pay 2¾ per cent. for borrowed money, and 2 per cent. for a sinking fund, which would make 4¾ per cent. My experience of local Government brings me to this conclusion. If a thing can be done by a corporation for a certain sum, it can be done by a contractor for a less sum, because there is always a certain amount of waste and expenses in connection with a local authority where the contractor would save.

Why should not the telephones be in the hands of some local authority. It is exceedingly important that they should be worked in the interests of the public at as cheap a rate as possible?—I do not think the telephone system is such a general need that Parliament would be justified in allowing the Corporation to pledge the rates for the purpose of supplying it. It would be a far sounder argument to say you should municipalise the butchers and the bakers shops. I think a properly regulated monopoly is better than any public service. The Corporation cannot get the thing into its hands until they have killed the Telephone Company, and I should be sorry to see the Liverpool Corporation competing with the National Telephone Company. It appears that the only profit the Post Office makes is the £70,000 a year from the telephone company.

Replying to Mr. Tully, Witness said he thought the National Telephone Company would introduce the twin-wire system if they were endowed with the powers he suggested. His impression was, if the municipalities got hold of anything which paid, the Postmaster-General would find it very difficult to get hold of it again; but of course it would be easy to acquire it if there was a loss.

By Sir Charles Cameron: He saw no possibility of a reduction in price under the agreement, and possibly there might be an increase, but that would not matter much if the trunk wires were extended. He understood that some of the Scotch boroughs had asked for licenses, and if they did not affect Liverpool, he did not see how he could object. In the event of municipal competition, he thought the company would reduce its charges, if another area had to make up for the loss.

Mr. Ellis: Do you draw any distinction between a commercial undertaking like this coming upon the rates as against the taxes?—I think the telephones were originally part of the Postmaster-General's monopoly, and, therefore, part of his duties, and I do not think it right, as a matter of policy, to allow corporations to go into trading concerns more than can be avoided.

Replying to Sir Frank Lockwood, Witness said he thought the agreement would be a benefit to the public if carried out. It seemed to him that if the municipality had the telephone in Liverpool it would practically bring it to an end, for in the Liverpool area there were three corporations—Liverpool, Bootle, and Birkenhead, besides ten or more local authorities. As a rule, Liverpool merchants did not live in the same place as their offices were situated, and the telephone to their houses had to go over two or three areas of different local bodies. It seemed utterly impossible to manage the telephone under such circumstances. The charge would necessarily be increased, because the Birkenhead authorities would not allow their lines to be used without a charge.

By the Chairman: He thought the system of municipal telephones would be detrimental to the whole country. If they once started the idea of isolation, he did not see how they could stop it.

The Chairman: As a matter of fact, no English corporation wishes for the telephone?—I never heard of one asking for it, or desiring it.

Mr. John Harrison, town clerk of Leeds, said he appeared on behalf of the Municipal Corporations Association. Speaking generally, he agreed with what Mr. Clare said, although on a few minor points he differed from him. In regard to the municipalisation of the telephones, he thought the best course would be for the Government to take over the system; next to that a strong company should work it, subject to restrictions and conditions. He could scarcely agree with the last witness that the municipalities would not care for competition if the conditions were not laid down, and if there should be competition, the municipalities would compete. Competition would be only justified in the absence of such conditions which would require the company to give a better service, and as to charges. He felt there was a great deal of force in what Mr. Clare said with regard to the extension of the company's license, but it was not a subject which had been greatly discussed. He thought the provisions in the agreement would meet the objections as to the breaking up of the streets. Of course, if there were two companies, it would mean breaking up the streets twice. He could not say that Leeds would enter into an arrangement with the telephone company the same as the Manchester Corporation had, but he thought probably they would. An agreement was made about five years ago in respect of a small portion of the town, and it had worked satisfactorily. The population of Leeds was 400,000, but the area of the company extended beyond the borough, and included populous districts. It would seriously curtail the advantages of the system if it was confined to a limited area in some respects, but in other respects they might get a better service, for Leeds was differently situated to Liverpool. There was dissatisfaction about the service in Leeds in consequence of the interruption of conversation, &c.

By Sir Charles Cameron: One of the points on which he differed from Mr. Clare was in respect of the importance of the communication within the town as compared with the communication between town and town. At present there was a great deal of communication within the municipal area. As a matter of fact, the Municipal Corporations Association had never expressed an opinion as regarded competition.

By Mr. Tully: He thought the Corporation should be supreme in the matter of breaking up the streets.

In reply to Mr. Fletcher Moulton, Witness said he considered it most important to have a cheap and efficient system, and if that could only be brought about by competition, he thought licenses should be granted, while there was no doubt in that case the corporations would be the last persons to compete. He thought it would be regrettable if there was competition, and he would only allow it where the company failed to give a cheap and effective service.

Sir James Ferguson: The Manchester terms are that the company agrees to lay twin wires as far as possible; the subscription is not to be increased without the consent of the Corporation; every citizen should be entitled to a supply, and no monopoly be conferred thereby. Don't you think such an arrangement would be better than the municipality having the telephone in its own hands?—I should specially want a maximum charge.

Provided a charge could be fixed, that could be considered fair? You think such an arrangement would be better than the Corporation having it themselves?—Yes.

Mr. W. H. Dickinson, Deputy Chairman of the London County Council, said that in 1892 the National Telephone Company brought in a Bill which would give them the powers of the old telegraph companies over the streets. The Council petitioned against the Bill, and it was not proceeded with. Subsequently, in October last, the

Council had the agreement before them, and afterwards a deputation waited on the Postmaster-General.

Sir Julian Goldsmid and Sir James Ferguson raised points of order as to the nature of the evidence Mr. Dickinson should be allowed to give.

The Committee conferred in private, and decided to adjourn till April 26th before proceeding with Mr. Dickinson's evidence.

## NEW PATENTS—1895.

6,114. "An improved filament for incandescent electric lamps." F. W. E. Jones. Dated March 25th.

6,127. "Improvements in feeding nailing and other machines of that class by means of electricity, and in apparatus used in connection with such machinery." R. J. Jones. Dated March 25th.

6,163. "Plate for secondary voltaic battery." W. A. B. Buckland. Dated March 25th. (*Complete.*)

6,164. "Automatic cut-out for suspended electrical conducting-wires." J. Schafer and P. Steffens. Dated March 25th.

6,171. "Improvements in multiple-switches for use with double telephonic leads." F. Srock. Dated March 25th. (*Complete.*)

6,177. "Improvements in alternating-current dynamos." W. B. Esson. Dated March 25th.

6,256. "Improved construction and arrangement of commutators for dynamos." J. W. Gilbert and S. Jevons. Dated March 26th.

6,258. "Improvements in apparatus for the electrolytic decomposition or purification of liquids." M. Stein and A. Wolf. Dated March 26th.

6,318. "New and useful improvements in the method of transmitting electric currents to electric railway cars." A. G. Waterhouse. Dated March 27th.

6,319. "New and useful improvements in electric current meters." A. G. Waterhouse. Dated March 27th.

6,320. "New and useful improvements in thermostat and electric switches or circuit brakes." A. G. Waterhouse. Dated March 27th.

6,351. "Improvements in dynamo-electric machines." W. M. Mordey and S. P. Thompson. Dated March 27th.

6,390. "Improvements in the method of and in apparatus for electrically lighting miners' safety lamps." J. Peel. Dated March 28th.

6,391. "Improvements in the method of and apparatus for switching on and off electric currents for electric lighting and other suitable purposes." A. Ballance and C. E. A. Fitz-Maurice. Dated March 28th.

6,400. "Improvements in and connected with the means of protecting electric conductors." J. A. Kingdon. Dated March 28th.

6,416. "Improvements in ceiling roses for electric-light fittings." F. W. Ball and J. H. Winter. Dated March 28th. (*Complete.*)

6,430. "Improvements in conduits for electrical conductors." J. F. Cummings and W. C. Yawkey. Dated March 28th. (*Complete.*)

6,455. "Improvements in apparatus for indicating and recording electric supply." W. Thomson (Baron Kelvin). Dated March 29th.

6,473. "An improved composition applicable as a substitute for natural cork and for other purposes, such as an electrical insulating material." E. Hermet. Dated March 29th.

6,494. "Improvements in and connected with electric alarm-clocks or alarm systems." E. Fuchs and M. Fuchs. Dated March 29th.

6,509. "Improvements in apparatus for electrically effecting the reproduction at a distance of graphic matter or designs matter, printed, stencilled, photographed, or otherwise produced." R. Greville-Williams. Dated March 29th.

6,536. "Improvements in apparatus for producing electrical effects on the stage." J. T. Niblett. Dated March 30th.

6,545. "An improved electric arc lamp for optical lanterns and other purposes." G. Davenport. Dated March 30th.

6,546. "Improved application of telegraph and telephone circuits." S. D. Williams. Dated March 30th.

6,557. "Improved apparatus applicable to the working of electric or lime lights for theatrical purposes." S. V. Evans. Dated March 30th.

6,565. "Improvements connected with the electrolytic production of alkali and chloride from sodium chloride solution and other substances." H. Tee. Dated March 30th.

6,575. "Improvements in apparatus for charging portable electrical accumulators or batteries." A. W. Bennett. Dated March 30th.

6,586. "Electric pneumatic action for organs." A. Price. Dated March 30th.

## ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1894.

249. "Improvements in electric switching apparatus, more especially intended for use on electrically propelled vehicles carrying both the source of electricity and the motors." F. King. Dated January 4th. The inventor arranges a set of blocks or contact pieces in permanent connection with subdivisions of the battery and connects these subdivisions in two or more ways as required for the purposes mentioned. 3 claims.

294. "Improvements in type printing telegraphic apparatus." W. P. Thompson. (A communication by J. Kustermann, of Lauchdorf.) Dated January 5th. Relates to a keyboard type printing telegraph. 4 claims.

439. "Improvements in girder clamps and hangers for supporting pipes, electric conductors, and the like." H. H. Lake. (Communicated from abroad by C. MacTaggart and F. McKernan, both of Philadelphia.) Dated January 8th. Comprises clamps or jaws adapted to embrace the flange of the girder or beam." 12 claims.

444. "Improvements in electric light fittings." C. S. Northcote and J. B. Verity. Dated January 9th. The inventors use a body of any suitable shape provided with any convenient number of nipples to carry the ordinary lampholders, and provided at the top with a plug piece, made in a similar way to the base of an ordinary incandescent lamp, supplied with contact plates to fit any ordinary lampholder. Inside the said body they provide terminals in connection with the contact plates, to which are attached one end of the supplying wires, the other end being attached to the lampholders at the bottom of the body. 3 claims.

690. "Improvements in electric apparatus for signalling on railways." R. S. Hampson. Dated January 12th. Relates to three wire block telegraph instruments, and particularly to permissive block telegraph instruments which allow two or more trains to be in one section at the same time and the chief object of the invention is to improve and simplify such instruments and reduce their cost. 5 claims.

908. "Improvements in apparatus for heating cylinders and parts of hydraulic machinery by the aid of electricity." W. L Williams, W. T. Goolden, and H. W. Ravenshaw. Dated January 15th. Relates to the heating of cylinders or parts of hydraulic machinery by the aid of electricity to prevent the freezing of the liquid used therewith, and consists of arrangements of the conductors of any electric current, whereby either the heat generated in such conductors is prevented from radiating to the outer atmosphere, and is communicated by conduction to the metal cylinders or casings containing water or other liquid of hydraulic machinery. 4 claims.

916. "Improvements in electrical measuring instruments." H. T. Harrison. Dated January 15th. Has reference to an improved electro-magnetic movement to be used in ammeters and voltmeters to measure direct or alternating currents. 2 claims.

923. "Improvements in high and low tension electric fuses." B. Deakin. Dated January 16th. Claim:—The arrangement and combination of the tube and air space passage or passages with the fuse and handle, substantially in the manner and for the purpose described.

1,115. "Improvements in safety devices for electrical circuits." A. Essinger and T. Harden. Dated January 18th. Relates more particularly to safety devices for use in cases where a high tension is reduced through a transformer to a low tension circuit. 4 claims.

1,433. "Apparatus for advertising by means of electric lamps." W. E. King. Dated January 23rd. Claim:—The arrangement of two or more circuits of ordinary incandescent lamps, which by means of a commutator or switch are rendered luminous in succession and produce a series of words, sentences or devices at the same place.

2,487. "Improvements in or relating to secondary batteries." C. J. Hall. Dated February 5th. Consists in making orifices or spaces in the plates used in such batteries, and in forming coils or spirals of thin lead which are inserted in the said orifices or spaces. 2 claims.

2,800. "Improvements in incandescent electric lamp fittings." E. F. A. Soleau. Dated February 8th. Consists essentially in connecting the one conductor with a central spring pressed stem and passing the other into a circular groove in an insulating piece so as to make contact directly or through a spring, in the groove, with the holder or socket. 2 claims.

3,080. "Improved method of fixing electric call bells." W. P. Theermann, W. Crookell, and G. C. Elliott. Dated February 13th. Relates to a method of fixing electric call bells, by which an ordinary trembling bell is made into a continuous action bell for calling servants or for other purposes. 1 claim.

3,859. "Improvements in or relating to electric gas lighting apparatus." W. P. Thompson. (A communication by M. Ulmer, of Nuremberg.) Dated February 22nd. In this apparatus one wire only is required for turning on the gas and producing igniting sparks. 8 claims.

4,177. "A new or improved reel device for fire-hose, electric cables, suspending cords, and the like." W. P. Thompson. (A communication by P. Schneider, of Germany.) Dated February 27th. Has for its object an arrangement of a coiling drum, and a hose-pipe, cable, or the like, wound thereon, in such a way that one end of the article wound on the drum is secured at a fixed end point, so that, by rotating the drum, the uncoiling of the cord or the like simultaneously takes place at both ends of the latter towards both sides, and the drum moves simultaneously away from the fixed end point of the cord, or the like, to the extent to which the corresponding coil of cord uncoils. 7 claims.

16,859. "Improvements in systems of electrical distribution." T. C. Cotkendall. Dated September 4th. Consists in providing a relatively high resistance path to line, preferably in the form of a shunt around the terminals of the break switch of such systems in order to maintain a constant path to line and providing the same with a suitable indicator for the current. 6 claims.